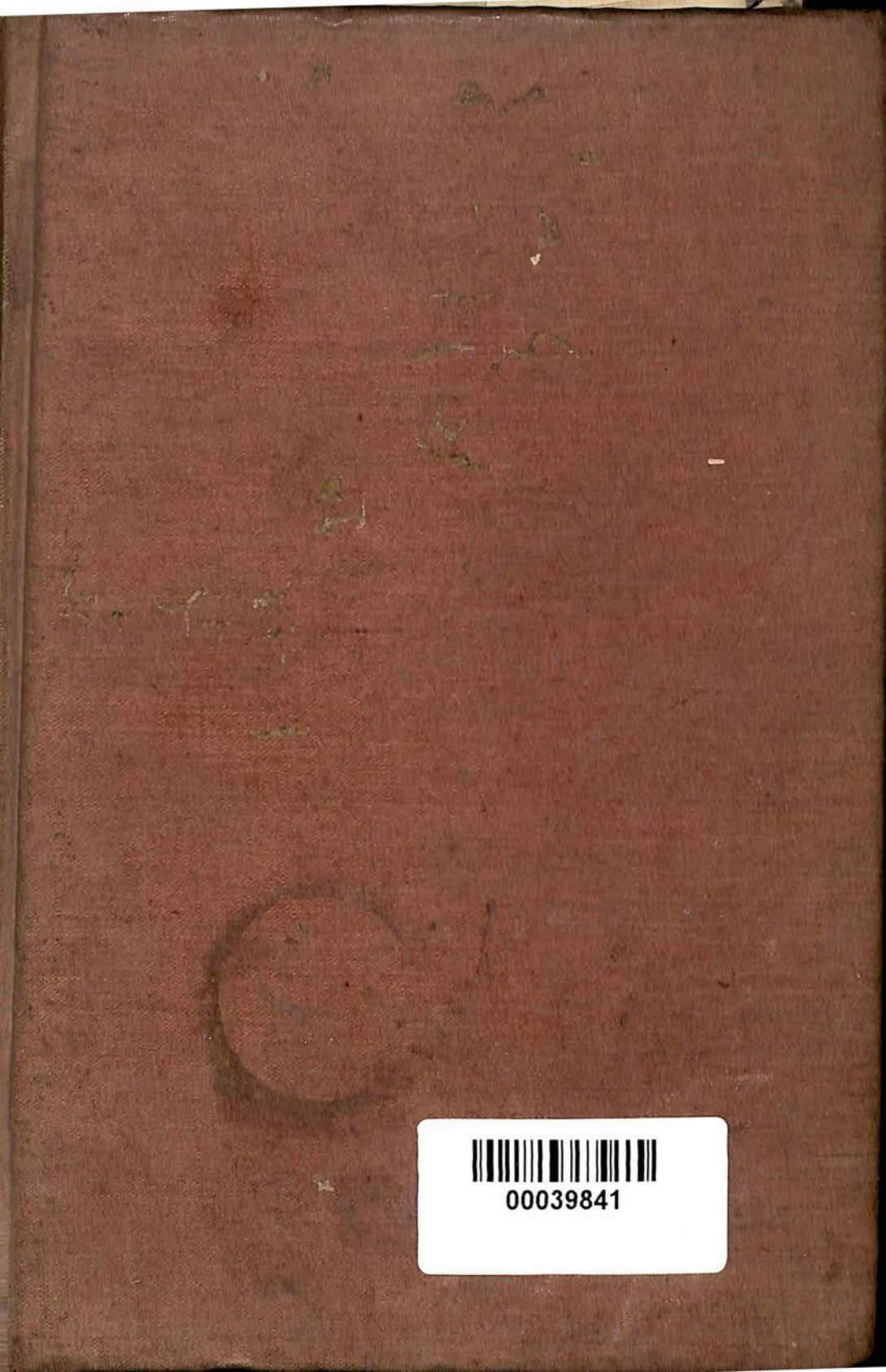
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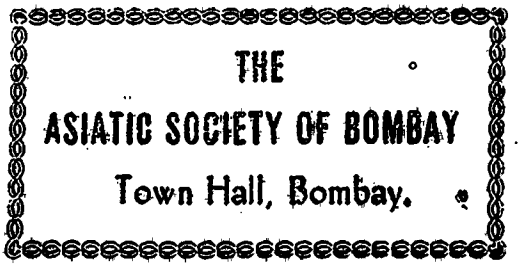

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FALCONER'S

PALÆONTOLOGICAL MEMOIRS

&c.

VOLUME I.

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PALÆONTOLOGICAL MEMOIRS AND NOTES

OF THE LATE

HUGH FALCONER, A.M., M.D.

VICE-PRESIDENT OF THE ROYAL SOCIETY;

FOREIGN SECRETARY OF THE GEOLOGICAL SOCIETY OF LONDON;
AND FOR MANY YEARS
SUPERINTENDENT OF THE H. E. I. COMPANY'S BOTANICAL GARDENS
AT SUHARUNPOOR AND CALCUTTA.

39841

WITH A

Biographical Sketch of the Author.

COMPILED AND EDITED BY

CHARLES MURCHISON, M.D., F.R.S.

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON.

VOL. I.

FAUNA ANTIQUA SIVALENSIS.

LONDON:
ROBERT HARDWICKE, 192 PICCADILLY.
1868.

00039841

TO

COLONEL SIR PROBY T. CAUTLEY, K.C.B.

MEMBER OF THE COUNCIL OF INDIA,

This Volume,

EMBRACING THE RESULTS OF HIS OWN RESEARCHES

AND THOSE OF HIS DEPARTED FRIEND AND COLLEAGUE

ON THE FOSSIL FAUNA OF THE SEWALIK HILLS,

WHICH OBTAINED FOR THEM

A WORLD-WIDE REPUTATION IN SCIENCE,

Is Dedicated

BY

THE EDITOR.

PREFACE.

ON the announcement of the death of Dr. Hugh Falconer, on January 31, 1865, there was but one feeling among men of science—that a master mind had passed away, and left little behind of the vast amount of palæontological knowledge acquired during a period of thirty years. Gifted with a memory rarely equalled, to which he too often confided the results of his researches, and having a natural aversion to publish his views without thoroughly sifting every fact which could be brought forward to corroborate or refute them, there can be no doubt that the loss to science consequent on his death is in a great measure irreparable. For many years, however, Falconer had been in the habit of noting down careful descriptions, with measurements, of many specimens which he believed to elucidate the subject of his investigations. The present work is a collection of memoirs, some of which were published during his lifetime, but many were not, together with such passages from his Note-books as have appeared to the Editor most important and complete.

The work is divided into two volumes, of which the first gives the results of the author's investigations on the Fossil Zoology of the Sewalik Hills, and the second is

composed of memoirs and observations, for the most part written subsequently to his return to Europe.

Many of the memoirs in the first volume have been already published, but in journals which are accessible to few scientific men in England or on the Continent. Others, though written many years ago, are now published for the first time. The researches on the Fossil Fauna of the Sewalik Hills were conducted by Dr. Falconer jointly with his friend Captain (now Sir Proby T.) Cautley, and all the new species were announced in their joint names. Some of the published memoirs appeared in the names of both, and others in the name of one only of these observers; but all have been here collected, so as to bring together as complete an account of the Sewalik Fossils as is now possible. With the same object, several short-notes by Messrs. Baker and Durand* have likewise been inserted. Most of the papers have also been enriched by appendices, in the form of extracts from Dr. Falconer's Note-books and correspondence, or from his published descriptions of the Sewalik Fossils in the Catalogue of the Asiatic Society's Museum in Calcutta. The first volume likewise comprises an Index to all the published plates of the 'Fauna Antiqua Sivalensis,' compiled by the Editor from entries in the author's Note-books, from references to the figures in his published memoirs, and from labels in his handwriting on the figured specimens now in the Palæontological Gallery of the British Museum. For assistance in identifying these specimens the Editor is under obligations to Mr. W. Davies of the British Museum. In the first volume will also be found a Report by Dr.

* Now General Baker, and General Sir Henry M. Durand, K.S.I.

Falconer of his expedition to Cashmeer and Little Tibet, in 1837-38, with notes and appendices.

Of the second volume certain of the memoirs have been already published, but many now appear for the first time, and particularly the important memoir and memoranda on the fossil species of Rhinoceros; while all have received valuable additions from the author's Note-books and letters.

It is necessary to state that many of the memoirs and notes now published were written long before the author's death, and that possibly he may have seen reason subsequently to modify or change certain of the views expressed. Any one who knew Falconer's extreme caution, and the frequency with which he revised and re-studied all his views and observations before committing them to the press, will probably feel that he would have deprecated the exposure which has now been made of what in some instances may have been only first impressions of the specimens which he described. But unfortunately, the powerful and discriminating intellect which would have erased the error of first impressions and moulded scattered observations into a harmonious whole was gone; and the question to be decided was, whether or not the observations carefully made, and in many instances minutely and accurately recorded by a shrewd, experienced, and conscientious searcher after truth, were to be for ever lost? As an executor of my departed friend, I have not hesitated in adopting the alternative which I believe will conduce most to the perpetuation of his name in Palæontological Science; while I am not the less assured that the publication of these volumes will meet with the approval of his former friends who still labour in the same field of research.

At the same time it ought to be distinctly understood, that many of the memoranda and notes which are now made public are not only fragmentary, but were simply the expressions of the author's mind at the dates which they bear. Throughout the volumes these notes are printed in smaller type than that of the finished memoirs.

Since Dr. Falconer's death the Editor has deposited in the Palæontological Department of the British Museum a large number of the specimens, casts, and drawings which are now for the first time described, and which will thus be accessible to those who may be interested in their examination. These include all the original drawings illustrating the important descriptions of Fossil Rhinoceros and *Elephas Melitensis*, copies of seventeen unpublished plates of the 'Fauna Antiqua Sivalensis,' as well as outline tracings for the drawings necessary to complete that work.

Falconer was not only a palæontologist, but a botanist of repute. His Indian career was spent as Superintendent of the Botanic Gardens of Suharunpoor and Calcutta, and in Calcutta he was also Professor of Botany in the Medical College. Of late years, however, he paid comparatively little attention to botany. But, although it is as a palæontologist that he will hereafter be remembered, several of his botanical memoirs are of great interest and value. A complete list of them is given in the first volume, but none of them have been reproduced.

The biography which is given in the first volume will not only interest Falconer's former friends, but will explain the circumstances under which some of his researches were undertaken, and others suspended. It has been constructed from brief memoranda written by him-

self, from letters addressed by him to his former fellow-students, the Rev. Dr. Gordon of Birnie, and the Rev. Duncan Campbell of Pentridge Rectory, to the late Professor Jameson of Edinburgh, and to his intimate friends Sir Proby Cautley, Mr. Arthur Grote, Colonel Wood, and M. Ed. Lartet, which have been kindly entrusted to me for the purpose, as well as from other sources. It might have been possible to extend it; but I have preferred incorporating the scientific information, which I have been enabled to extract from Dr. Falconer's correspondence, in the form of foot-notes, with the memoir to which in each case it refers. Throughout the work, the orthography of Indian names, on which scarcely two writers agree, is what was adopted by Dr. Falconer himself; while that of the specific names of fossils, as was Falconer's habit, has been rendered in accordance with Bronn's 'Nomenclator Palæontologicus.'

The admirable lithographs which illustrate the work have been executed by Mr. Joseph Dinkel, and have been partly copied from figures in the 'Fauna Antiqua Sivalensis,' or from original drawings belonging to Dr. Falconer, and partly drawn from the original specimens in the British Museum or in other collections. The Rev. John Gunn of Irstead, with his wonted readiness to render his valuable collection available for the advancement of science, has forwarded several of his specimens to be figured.

To the Editor of these volumes it is a matter of regret that the work which he has now completed has not been executed by some one more competent to deal with the subjects of which they treat, and less liable to professional interruptions. But as the object has been to place the results of Dr. Falconer's labours before the

scientific public without any addition or comment, an expert in the science did not seem necessary; while the time required for collecting and arranging his widely-scattered observations would, probably, have precluded any of the small number of British palæontologists from undertaking the task. Lastly, although further delay might have rendered the work more complete, this advantage would have been more than counterbalanced by the loss to palæontologists, in the meantime, of the results of some of Falconer's researches.

'Nec dubitamus multa esse quæ nos præterierunt: homines enim sumus et occupati officiis, subsecivisque temporibus ista curavimus.'[1]

[1] Pliny, Præf. in 'Nat. Hist.'

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DESCRIPTION OF PLATE II.

Map illustrating Dr. Falconer's Observations on the G
logy of India (p. 28). This map is reduced from a large
which Dr. Falconer had coloured, and to which he had af
the following explanatory note. The different shadings
respond to the colours in the original.

'The great mass of *light shading* represents the supposed *insula*
of the continent of India at an early period of the Tertiary epoc
island forming a sort of triangle, of which the eastern and western
formed the sides and the great Vindhya range the base, with an i
patch of mountainous country stretching north forming the A
range.

'The *dark shading* represents the plains of India, forming the
systems of the Ganges and Indus drainage, which were formerly
ocean straits. These straits were the recipients of the silt and al
washed out of the Himalayahs, and were at length elevated ab
sea, so as to form the existing continent. The Sewalik Fau
spread over the continent, from the mouth of the Irrawaddi to t
of Cambay 2,000 miles, and north to the Jhelum 1,500 miles.
the long establishment of the Sewalik Fauna, a great upheaveme
place along the line of the Himalayahs, elevating a narrow bel
plains into the Selawik Hills, and adding many thousand feet
height of the Himalayahs. The *red* stripe represents the Sewali
stretching from the Hydaspes to the Gunduck River, 800 miles
small *red* patch behind the Himalayahs represents the ossiferous
Tibet about 16,000 feet above the sea. The other *red* patches
sent the Nerbudda and the Gulf of Cambay fossil tracts.'

Map illustrating Dr Falconers observations on the Geology of India

CORRIGENDA AND ADDENDA.

Page	22	line	15.	*For* Netee Pars, *read* Niti Pass.
„	23	„	1.	*For* Brahmatherium, *read* Bramatherium.
„	23	„	7.	*For* Antelope Palæindicus, *read* Antilope Palæindica.
„	24	„	30.	*For* Successively, *read* successively.
„	31	„	5	of foot-note. *For* planes, *read* plains.
„	31	„	7	of do. Add inverted comma after mountains.
„	38	„		In description of Fig. 4, *for* '*a.* Clay,' *read* '*a.* Upper soil.'
„	53	„	1	of foot-note 3. *For* do *read* di.
„	157	„	35.	*For* tichorinus, *read* tichorhinus.
„	162	„	21.	*For* Maginnud, *read* Moginund.
„	170	„	2	*For* Maginnud, *read* Moginund
„	218	„	1.	*For* conicle, *read* conical.
„	218	„	8.	*For* anteror, *read* anterior.
„	218	„	13.	*For* vallies, *read* valleys.
„	301	„		3rd column of Table. *For* Pethecus, *read* Pithecus.
„	306	„	2.	*For* channoled, *read* channolled.
„	339			Since this page was printed, the Editor has had an opportunity of perusing a letter from Dr. Falconer to M. de Blainville, dated October 4, 1847, in which reference is made to *two species* of fossil Hyæna, and to *two species* of fossil Felis (*F. cristata* and *F. palæotigris*), from the Sewalik Hills. Casts of these fossils were transmitted to the Jardin des Plantes.
„	440	„	2.	*Omit* Reproduced in Plate IX. of Vol. II.
„	441	„	6 & 7.	*For* first, or antepenultimate, *read* pre-antepenultimate (*a*), antepenultimate (*b*).
„	467			Under fig. 5 of Plate XXXVI., *for* last? *read* penultimate.
„	468	„	7.	*For* Portwick, *read* Postwick.
„	502	„	5.	*Omit* The drawing shows the descending process of the jaw.
„	502 and 503.			*Substitute* upper jaw for lower jaw, *in descriptions of figures* 1, 3, 11, *and* 15 *of Plate LXII.*
„	513	line	10.	*For* tichorinus, *read* tichorhinus.
„	524	„	4	of description of Fig. 4. *For* premolars, *read* premolar.
„	546	„	6	of description of Fig. 7. *For* p. 354, *read* p. 554.
„	554			In a letter to M. de Blainville, dated October 4, 1847, Dr. Falconer designated certain remains of the Sewalik fossil birds, '*Struthio palæindica.*'
„	582	„	18 & 22.	*For* Martin, *read* Marton.
„	587			*For Cervus Duvancelli, read* Cervus Duvaucellii.

BIOGRAPHICAL SKETCH.

ON the 29th of February, 1808, HUGH FALCONER was born at Forres, in the North of Scotland—a town beautifully situated on the banks of the Findhorn, but best known from its traditional connection with the 'blasted heath' of Macbeth. He was the youngest of a family of five sons and two daughters, his father, Mr. David Falconer, being a descendant of an ancient family, the Falconers of Lethen and Halkerton. He received his early education at the Grammar School of Forres, where he attracted the notice of his teachers from his wonderful memory and facility for acquiring languages; and then, aided by the resources of an elder brother in India, he entered the University of King's College, Aberdeen, to pass through the established Scotch Academical curriculum of classical literature and science, extending over a period of four years. A fellow student, who was very intimate with him at that time, remembers well his diligence and steady conduct, and adds that even then, 'he was an immense favourite with his classfellows, and was remarked for his playful genial humour, and frank, generous, winning disposition,' and that 'they who watched him closely could detect in the young student the penetrating intellect and shrewdness in observing which distinguished the future palæontologist.'[1] Reading was always his favourite amusement, and although the subjects which he studied were very varied, he was especially fond of everything relating to Natural History. A book entitled 'The Three Hundred Animals' was an especial favourite,

[1] Letter from the Rev. Duncan Campbell.

and the intervals of his sessions at King's College, when he was a pupil of Drs. Smith and Adams of Forres, were chiefly spent in studying the botany of the neighbourhood and in watching the habits of the many animals which he kept as pets. After receiving the degree of Master of Arts at Aberdeen, in 1826, he proceeded to Edinburgh to enter on the study of Medicine. Here he eagerly followed up his early tastes for Natural History, under the systematic tuition of the late Professor Graham in Botany, and Professor Jameson in Geology and the other branches of Natural History. According to the testimony of one who knew him well, 'he laboured with untiring energy. Shut up in his apartments for days together, he allowed himself little relaxation except that of accompanying the great Wernerian Professor in his Geological excursions with wallet and hammer, which he never failed to do.'[1] His range of study, however, at this time was perhaps too excursive for solid attainment in any one walk; for, besides attendance on the numerous classes in Medicine and Natural History, he matriculated as a student in Divinity, in order to benefit by the renowned teaching of Dr. Chalmers, then Professor of Divinity in the University. In 1829 he received the degree of M.D. from the Edinburgh University, his graduation thesis being entitled 'De Chorea.'

In the same year he was nominated to the appointment of Assistant-Surgeon on the Bengal establishment of the Hon. East India Company, but not having attained the required age of 22 years, he proceeded to London, where he devoted the necessary interval to assisting the late Dr. Nathaniel Wallich in the distribution of his great Indian Herbarium; and, under the generously bestowed instruction of Mr. Lonsdale, to the further study of Geology and Palæontology. The Museum of the Geological Society of London, under the charge of Mr. Lonsdale, gave him access to the collection of Indian fossil mammalia from the banks of the Irrawaddi, formed by Mr. John Crawfurd during his mission to Ava. The description of these remains by Mr. Clift had excited much interest in the scientific world, as the first instance in which ground had been broken in the palæontology of tropical regions.

[1] The Rev. D. Campbell.

In 1830 Dr. Falconer proceeded to India as an Assistant-Surgeon in the Hon. East India Company's service, and arrived in Calcutta in September of the same year. Here he at once undertook an examination of fossil bones from Ava, in the possession of the Asiatic Society of Bengal, and published a description of them in the third volume of the 'Gleanings in Science,' an Indian journal then conducted by Mr. James Prinsep. This notice[1] was slight and modest in its scope; but the cultivators of Science in India were then few in number, and its appearance at once gave Falconer a recognized position in their roll.

Early in 1831 Dr. Falconer was ordered to the army station at Meerut, in the North-Western provinces. His first and last military duty, during twenty-six years of service, was to take charge of a detachment of invalids proceeding from Meerut to the sanitarium of Landour, in the Himalayahs. This led him to pass through Suharunpoor in April 1831, where the late Dr. Royle was then superintendent of the Botanic Garden. Kindred tastes and common pursuits soon knit Falconer and Royle together; and, at the instance of his friend, Falconer was speedily appointed to officiate for him during leave of absence, and, on Royle's departure for Europe, in 1832, to succeed him in charge of the Botanic Garden. Thus, at the early age of twenty-three, did he find himself advanced to a responsible and independent public post, offering to a naturalist the most enviable opportunities for research; so fertile was the Indian service then in chances to rise for any young officer who chose to make the exertion.

Suharunpoor is situated in lat. 29° 58′ N. and long. 77° 30′ E., between the Jumna and Ganges rivers, outside the belt of Terai forest, which lies between the mountains and the plains, and is distant about twenty-five miles from the Sewalik Hills, beyond which rise the Himalayahs. It is thus most favourably situated as a central station for Natural History investigations; the rivers, plains, forests, and hills teeming with life in every shape, and the range of elevation combining, within a short distance, the features and productions of tropical temperature and alpine regions insensibly

[1] See p. 412 of this volume.

blended. Being a remote provincial station, with at that time only half-a-dozen European families, the white man had to draw on local means in all emergencies where the appliances of civilized life were required; but the intelligence, docility, and exquisite manual dexterity of the natives, backed by their faith in the guiding head of the European, furnished an inexhaustible fund of resource. To construct, for example, a barometer for mountain explorations, broken tumblers were melted and blown into a tube; mercury was distilled from cinnabar purchased in the bazaar; a reservoir was turned out of box-wood felled in the mountains; and finally a brass scale was cast, shaped, and even graduated, by a native blacksmith, under the superintending eye of the amateur. Or again, he might be seen superintending the expression of some indigenous oil as a substitute for salad oil, when the European supply had been exhausted. Such discipline was of infinite value in training the young officer to habits of self-reliance and to kindly relations with those among whom his lot was cast, and no doubt contributed to that great fund of universal information for which Falconer was afterwards so remarkable.

In 1831 Dr. Falconer commenced his field explorations, by investigating the geological formation of the Sewalik Hills. Captain Herbert, in his mineralogical survey of the N. W. Himalayahs, had referred the Sub-Himalayahs to the age of the 'New Red Sandstone;' but Dr. Falconer, on his first visit, from finding beds of incoherent gravel covering the northern slope of the range, from the occurrence of seams of lignite and dicotyledonous woods discovered by Lieutenant Cautley in 1827, and from the mineral characters of the different strata, inferred that they were of a tertiary age, and analogous to the *Molasse* of Switzerland.[1] Thirty years of subsequent research by other geologists have not altered that determination, although our exact knowledge of the formation has been greatly extended. Early in 1834 Dr. Falconer gave a brief account of the Sewalik Hills, describing their physical features and geological structure, with the first published section showing their relation to the Himalayahs.[2] The name 'Sewalik' had been vaguely applied

[1] Journal Asiatic Society of Bengal, March 1832, vol. i. p. 96; and letter to the late Professor Jameson of Edinburgh University, February 8, 1836.

[2] Ib., vol. iii. p. 182.

before then by Rennell and others to the outer ridges of the true Himalayahs, and the lower elevations towards the plains. Dr. Falconer restricted the term definitely to the flanking tertiary range, which is commonly separated from the Himalayahs by valleys or *Dhoons*. The proposed name was not favourably received at the time by geographical authorities in India; but it is now universally adopted in geography and geology, as a convenient and well-founded designation.

When, in 1831, Dr. Falconer determined the tertiary age of the Sewalik Hills, the confirmatory evidence of animal remains was wanting; but he was led to the conclusion 'that the remains of Mastodon and other large extinct mammalia would be found either in the gravel or in other deposits occupying the same position in some part of the range, and the notice in Ferishta's Indian History of the bones of giants being found in the hills in which the Sutlej took its origin made this opinion the more probable.'[1] Still other geologists, including Govan, Herbert, and a sharp-eyed observer like Jacquemont, had previously gone over the ground, but had failed to detect any fossil remains. Towards the end of 1831, Dr. Falconer, from the indication of a 'black cylindrical fossil,' found some years before by his friend and colleague Capt. (now Sir Proby T.) Cautley, but the real nature of which had been previously overlooked, was led to discover bones of crocodiles, tortoises, and other fossil remains in the tertiary strata of the Sewalik Hills. A brief notice of this important discovery, extracted from a letter by Dr. Falconer, appeared in the 'Journal of the Asiatic Society' for March 1832.[2] In April 1834, Dr. Falconer discovered the shell of a fossil Tortoise in the Timli Pass, and immediately after the search was followed up with characteristic energy by Capt. Cautley in the Kalowala Pass by means of blasting, and resulted in the discovery of more perfect remains, including Miocene mammalian genera. The finding, therefore, of the fossil fauna of the Sewalik Hills was not fortuitous, but a result led up to by researches suggested by previous special study, and followed out with a definite aim.

The researches thus begun were followed, about the end of 1834, by the discovery by Lieutenants Baker and Durand of

[1] Letter to Professor Jameson.

[2] Op. cit. vol. i. pp. 96 and 249, and letter to Professor Jameson, already referred to.

the great ossiferous deposit of the Sewaliks, near the Valley of Murkunda, and below Nahun. Lieut. Baker's attention had been directed to this by his having been presented by the Nahun Rajah with a fragment of tusk and the fossil tooth of an Elephant,[1] which had been picked up at Sumroti, near the Valley of Pinjore, and which the Rajah regarded as the remains of giants destroyed by the redoubtable Ramchundra. Capt. Cautley and Dr. Falconer were immediately in the new field. Falconer's enthusiasm may be judged of from the following extract of a letter to Mr. Prinsep:—

'You have heard from Capt. Cautley and Lieut. Baker about the late fossil discovery up here. I have come in for a lion's share of them. In one of my tours I had to return by Nahun, and having heard of the tooth presented by the Rajah, in October, to Lieut. Baker, I made inquiry, and had a fragment of tooth presented to me also. I got a hint of where they came from, and on going to the ground, I reaped a splendid harvest. Only conceive my good fortune. Within six hours I got upwards of 300 specimens of fossil bones! This was on November 20th, a couple of days after Lieuts. Baker and Durand had got their first specimens through their native collectors.'[2]

Similar remains were subsequently discovered by Dr. Falconer in the Sewalik range eastward of the Ganges, near Hurdwar.[3] By the joint labours of Cautley, Falconer, Baker, and Durand, a sub-tropical mammalian fossil fauna was brought to light, unexampled for richness and extent in any other region then known. It included the earliest discovered fossil *Quadrumana*, an extraordinary number of *Proboscidea* belonging to *Mastodon*, *Stegodon*, *Loxodon*, and *Euelephas*; several extinct species of *Rhinoceros*; *Chalicotherium*; two new subgenera of *Hippopotamus*, viz. *Hexaprotodon* and *Merycopotamus*; several species of *Sus* and *Hippohyus*, and of *Equus* and *Hippotherium*; the colossal ruminant *Sivatherium*, together with fossil species of *Camel*, *Giraffe*, *Cervus*, *Antilope*, *Capra*, and new types of *Bovidæ*; *Carnivora* belonging to the new genera *Hyænarctos* and *Enhydriodon*, and also to *Drepanodon*, *Felis*, *Hyæna*, *Canis*, *Gulo*, *Lutra*, &c; among the *Aves*, species of *Ostrich*, *Cranes*, &c.; among the *Reptilia*, *Monitors*,

[1] This tooth was described and figured by Lieut. Baker in the Journ. As. Soc. of Bengal for December, 1862, and was subsequently determined by Dr. Falconer to belong to *Elephas Ganesa*.

[2] Journ. As. Soc., vol iv. p. 57.

[3] 'Note on the Occurrence of Fossil Bones in the Sewalik Range, eastward of Hurdwar.'—Journ. As. Soc. of Bengal, vol. vi. p. 233, 1837.

and *Crocodiles*, of living and extinct species, the enormous Tortoise, *Colossochelys Atlas*, with numerous species of *Emys* and *Trionyx*; and among fossil Fish, *Cyprinidæ* and *Siluridæ*. The general facies of the extinct fauna exhibited a congregation of forms participating in European, African, and Asiatic types. Of the mammalian remains all belonged to extinct species, but of the *Reptilia* and Freshwater Shells, some of the fossil species were identical with species now in existence on the continent of India; and from this fact, more than thirty years ago, Dr. Falconer was led to draw important inferences as to the antiquity of the human race.

Thrown suddenly upon such rich materials, the ordinary means resorted to by men of science for determining them by comparison were wanting. Of palæontological works or osteological collections in that remote quarter of India there were none. But Falconer was not the man to be baffled by such discouragements. He appealed to the living forms abounding in the surrounding forests, rivers, and swamps to supply the want. Skeletons of all kinds were prepared; the extinct forms were compared with their nearest living analogues, and a series of memoirs by Dr. Falconer and Captain Cautley, descriptive of the most remarkable of the newly discovered forms, appeared in the 'Asiatic Researches,' the 'Journal of the Asiatic Society of Bengal,' and in the 'Geological Transactions.' The Sewalik explorations soon attracted notice in Europe, and in 1837 the Wollaston Medal, in duplicate, was awarded for their discoveries to Dr. Falconer and Capt. Cautley by the Geological Society, the fountain of geological honours in England; while the value of the distinction was enhanced by the terms in which the president, Mr. (now Sir Charles) Lyell was pleased to announce the award.

'When,' remarked the President, 'Capt. Cautley and Dr. Falconer first discovered these remarkable remains, their curiosity was awakened, and they felt convinced of their great scientific value; but they were not versed in fossil osteology, and, being stationed on the remote confines of our Indian possessions, they were far distant from any living authorities or books on Comparative Anatomy to which they could refer. The manner in which they overcame these disadvantages, and the enthusiasm with which they continued for years to prosecute their researches, when thus isolated from the scientific world, are truly

admirable. Dr. Royle has permitted me to read a part of their correspondence with him, when they were exploring the Sewalik mountains, and I can bear witness to their extraordinary energy and perseverance. From time to time they earnestly requested that Cuvier's works on Osteology might be sent out to them, and expressed their disappointment when, from various accidents, these volumes failed to arrive. The delay, perhaps, was fortunate; for, being thrown entirely upon their own resources, they soon found a Museum of Comparative Anatomy in the surrounding plains, hills, and jungles, where they slew the wild tigers, buffaloes, antelopes, and other Indian quadrupeds, of which they preserved the skeletons, besides obtaining specimens of all the reptiles which inhabited that region. They were compelled to see and think for themselves, while comparing and discriminating the different recent and fossil bones and reasoning on the laws of comparative osteology, till at length they were fully prepared to appreciate the lessons which they were taught by the works of Cuvier.'[1]

These Sewalik researches, interrupted for a time by distant employment on other duties, were subsequently resumed by Dr. Falconer in England.

Concurrently with these investigations, Dr. Falconer's official duties, as Superintendent of the Suharunpoor Botanic Garden, led him to explorations in the snowy range of the neighbouring Himalayahs.

In 1834 a Commission was appointed by the Bengal Government to inquire into and report on the fitness of India for the growth of the tea-plant of China. Acting on the information and advice supplied by Dr. Falconer,[2] the Commission recommended a trial. The Government adopted the recommendation; the plants were imported from China, and the experimental researches were placed under Falconer's superintendence in sites selected by him. Tea culture has since then greatly extended in India, and the tea of Bengal bids fair to become an important commercial export from India, as Falconer long ago predicted.

In one of his expeditions, in July and August 1834, in search of sites for tea-plantations, Dr. Falconer succeeded in

[1] Address at anniversary meeting of Geol. Soc. February 17, 1837; ib. vol. vi. p. 890.

[2] On the Aptitude of the Himalayahs for the Culture of the Tea Plant.—Journ. As. Soc. of Bengal, 1834, vol. iii. p. 182. The following is an extract from a letter from Dr. Falconer to Sir Proby Cautley, dated May 2, 1844: 'My tea services are undeniable. The experiment was attempted on my recommendation, and conducted under me; the first tea was manufactured under me, and the produce declared by three sets of brokers to be equal to the best China tea.'

ascending the Jumnootree as far as the hot springs at the sources of the Jumna. His diary kept during this journey is full of interest. He dwelt with much force on the singular contrast to the Alps of Switzerland, or the Highlands of Scotland, presented by the Himalayahs in the absence of lakes,[1]—a fact which many years afterwards he handled with his wonted vigour in the discussion upon the Glacier-Erosion theory of lake-basins. Between Mussooree and Deobun he discovered *greenstone trap*. He also described a section of the bed of the Jumna at Burkot, which he believed to possess great interest in connection with the Sewalik Hill formation. It consisted of schistose primitive rocks with a superimposed layer of unstratified gravel, forming a cliff upwards of 50 feet above the level of the river, and exactly like that found in the Kheeri and Kalowala passes. It appeared to Dr. Falconer that this was due to 'a diluvial action higher up the valley, perhaps the sudden disruption of a large volume of water, forming a mighty wave which swept along suspended in it an enormous quantity of gravel and left it deposited as at Burkot, at intervals in its course, where the velocity of the stream might have diminished, and which rushed on to the plains, where, disemboguing from its contracted channel, it spread out and left the gravel deposit now crowning the Sewalik Hill formation, previous to their upheaval.'

A letter written to the Rev. Dr. Gordon of Birnie, N.B., soon after his return from the Jumnootree, contains the following paragraph:—

'The rock formations of the Himalayahs are all primary: the Sub-Himalayan is very recent. In the outer ridges you get limestone and the newer primary rocks (transition). As you go on, gneiss, mica-slate, &c. succeed. In the outer ridges the volcanic rocks are greenstone traps (I believe I was the first to make this out), often with porphyritic crystals, and here and there unstratified quartz rock. As you go inwards you get granite and syenite. On the southern side of the snow peaks there are more recent formations, and I should not have said that the Himalayahs are *entirely* primary. You there get limestone with *Ammonites*, *Orthocerates*, *Trilobites*, and *Terebratulæ*, as in the mountain limestone of England. The snowy range or central ridge has an

[1] 'Lakes are scarcely anywhere seen in the Himalayahs. This singular feature strikes any one who has seen the Highlands of Scotland or travelled in the Alps,' &c.

elevation varying from 15,000 to 26,000 feet. Perhaps the mean height may be from 18,500 to 19,000. The snowy mountains are not, as in the *Andes*, interrupted peaks here and there of porphyries and other traps, but a continuous line of ridges, and the highest of them are certainly primary schists, such as gneiss, &c. You may remember, perhaps, Jameson's doubts about this point. But I am convinced that they are only huge masses of the same formation as the lower ridges, upheaved to a greater elevation. The scenery is magnificent; like Byron's ocean, "Endless, boundless, and sublime"; huge, vast, and awe-striking. To give you an idea of some of the views: I got up on the top of a high mountain called Choor, half way between the snowy range and the plains, with an elevation of about 13,000 feet. In front, looking to the north, the eye took in a continuous line of snowy ridges, varying from 15,000 to 24,000 feet, or no less than 90° on a quadrant of the horizon. This is no exaggeration. Between me and them stretched an ocean of mountain waves, I overtopping all. In the rear, or south, stretched another sea of mountain-ridges, with the plains of India in the distance, level as a lake, traversed here and there by a streak of silver marking the tiny show made by the mighty rivers Jumna and Ganges, and then turning to right and left was a stretch of ridge upon ridge and of mountain upon mountain, bounded only by the limits of vision. I stood upon pinnacled masses of granite, which made a noble and harmonious offset to the whole. Follow me on another occasion to the source of the river Jumna, at the foot of the mountain Jumnootree, 21,000 feet high, I walking in the bed of the river, in a narrow winding channel, cutting off the view in every direction, with a lofty wall of rock on either hand. Imagine now a sudden bend of the channel opening a vista in front, and the mountain bursting on the view rising nearly two miles in height right over me, its black front patched over and its summit crested with snow, looking like an enormous wave curling with foam and rolling on to overwhelm us. So vivid was this impression, that astounded awe was the first feeling, and it required an exertion of reason to get over it.'

In this and other expeditions, as well as by means of trained native collectors dispatched in different directions as far as Cashmeer and the borders of Chinese Tartary, Dr. Falconer made large additions to Indian Botany, which have been freely acknowledged by Dr. Royle and other botanical writers. Dr. Royle[1] states that Falconer's 'untiring zeal induced him to travel much in the midst of the rainy season,

[1] Illustrations of Botany of the Himalayahs, vol. i. 1839, pp. 362, 367. A new genus of the family of *Antidesmeæ* was designated by Dr. Royle, *Falconeria*, in honour of his friend Dr. Falconer, 'who is as zealous and able a botanist as he has shown himself to be a distinguished zoologist.'—Ib., p. 354.

to the great risk not only of his health, but of his life,' and from Falconer's diary it appears that during his trip to Jumnootree he was so seriously ill that on two occasions he thought it necessary to bleed himself to a large amount.

Not content with investigating the Natural History productions of the country surrounding Suharunpoor, Dr. Falconer had repeatedly expressed a desire to visit Cashmeer for the same object. Accordingly in June 1837, on the occasion of Burnes's second mission to Caubul, which preceded the Afghan war, Dr. Falconer, along with Lieutenant Mackeson, was ordered by Lord Auckland, on the recommendation of Captain Wade and Dr. N. Wallich, to join the party, and then proceed into Cashmeer and the countries north of that valley. United at Peshawur, the party consisted of Burnes, Mackeson, Leech, Lord, Wood, and Falconer. Of these six officers, Wood, the explorer of the Oxus, alone survives. In his journey from Loodianah to Peshawur, Dr. Falconer found the Sewalik fossils all along the Sub-Himalayan range from Jhelum on to Rawul Pindee. After exploring the neighbourhood of Peshawur he detached himself from the rest of the party and proceeded westward to Kohat and the lower part of the Valley of Bunguish, in order to examine the Trans-Indus portion of the Salt-Range, and then, in company with Lieutenant Mackeson, who many years later was cruelly assassinated by a fanatic at Peshawur, he made for Cashmeer, reaching the town of Cashmeer at the latter end of September. Soon after their arrival Lieutenant Mackeson received instructions to return at once to Peshawur, but Dr. Falconer remained at Cashmeer, where he passed the winter and spring examining the natural history of the valley and making extensive collections. He lived in the same house which had formerly been occupied by the celebrated traveller, Moorcroft, and here, for many weeks in December and January, he suffered from an alarming illness, which reduced him to a state of extreme prostration. The following summer (1838) he crossed the mountains to Iskardoh in Bulkistan, and by the aid of Rajah Ahmud Shah traced the Shiggur branch of the Indus to its source in the glacier on the southern flank of the Mooztagh range, now ascertained to be 28,200 feet above the level of the sea. Having examined the great glaciers of Arindoh and of the

Braldoh valley, he returned to Cashmeer by the Valley of Astore, where he discovered the Assafœtida plant of commerce, which he was the first to describe. On October 10th he reached Cashmeer, from which he set out again on the 22nd, on his return journey through the Punjab to Suharunpoor. During this second visit to Cashmeer and part of the journey through the Punjab he was again severely ill. It was during this return journey that he discoverd the Sewalik formation with the remains of Mastodon, &c., in the hills between the Punjab and Cashmeer. During his stay in Cashmeer, Dr. Falconer transmitted to the Botanic Gardens at Suharunpoor 650 grafted plants, comprising all the more valuable fruit-trees of Cashmeer, with plants of the Prangos Grass; and on his arrival at Suharunpoor, early in December 1838, his collections in Botany, Zoology, and Geology amounted to nine cart-loads. Besides the plants yielding Assafœtida and *koost*, articles of considerable commercial value, they included numerous new species of plants, 587 sorts of seeds, 234 skins of birds, and 30 specimens of Mammalia, including one new species of *Cervus*, two of *Capra*, and one of *Moschus*—the details of which will be found in Dr. Falconer's official account of the expedition, and in the notes and appendices.[1]

In 1841, Dr. Falconer addressed a letter to the Secretary of the Asiatic Society on the then recent Cataclysm of the Indus, and while advocating a careful Government investigation of its causes, suggested as an explanation a temporary obstruction of the river with snow or ice above Iskardoh. This he supposed had dammed up the water and caused the river to be so low, that at Attock, in place of being as usually, many fathoms, it was fordable. All at once the obstacle had given way, and a mighty flood coming down had swept everything before it.[2]

In 1840, Dr. Falconer's health, shattered by previous attacks of severe tropical diseases—the results of incessant exposure—gave way; and alarming symptoms setting in, he was compelled in 1842 to seek for recovery by returning to Europe on sick leave. He brought with him the Natural History collections amassed during ten years of exploration. They amounted to seventy large chests of dried plants from

[1] See vol. i. p. 557.
[2] Journ. As. Bengal, vol. x. p. 615. July 1841.

Cashmeer, Afghanistan, Tibet, the Punjab, the Himalayahs, the plains of the N.W. provinces, and from the neighbourhood of Darjeeling, Assam, and Sylhet; and forty-eight cases containing five tons of fossils bones, together with geological specimens, illustrative of the Himalayan formations from the Indus to the Gogra, and from the plains of the Punjab across the mountains north to the Mooztagh range.

From 1843 to 1847 Falconer remained in England. He occupied this time in publishing numerous memoirs on the geology and fossil remains of the Sewalik Hills, which appeared in the 'Transactions' of the Geological Society, and in the 'Proceedings' of the Zoological Society, of the British Association, and of the Royal Asiatic Society, and which have been reproduced in these his collected works. He had now an opportunity of comparing the Indian fossils with the metropolitan collections of Palæontology and Comparative Anatomy. On his arrival he was at first so weak that for several weeks he was unable to walk, but his first visits were to the Royal College of Surgeons and the British Museum; and he at once wrote off a glowing account of the treat which he had received to Captain Cautley, in India. He might well contrast the advantages enjoyed by the palæontological student in London with the difficulties which he and his colleague had so ably surmounted in India. He also communicated several important papers on Botanical subjects to the Linnean Society;[1] of which may be specially mentioned that on *Aucklandia Costus*, the Cashmeer plant which yields the *Kostos* of the ancients; and that on *Narthex Assafœtidæ*, which was the first determination of the plant, long contested among botanists, which yields the Assafœtida of commerce, and which he had found growing wild in the Valley of Astore, one of the affluents of the Indus. His extensive botanical collections, on which he had bestowed so much labour, were unfortunate. Having partially suffered from damp on the voyage to England, they were left deposited in the East India House during Falconer's second absence in India, and the specimens underwent a ruinous process of decay. Those which escaped were obtained in 1857 from the Court of Directors, by Dr. J. D. Hooker, for the Museum at

[1] See List of Botanical Memoirs at p. lv.

Kew. Respecting this collection, Dr. Hooker and Dr. Thomson thus wrote in the 'Flora Indica,' published in 1855:—

'We cannot conclude this comprehensive catalogue without an allusion to the labours of Dr. Falconer, one of the most estimable, able, and accomplished of Indian botanists; to whose liberality and good offices we were in many ways indebted as travellers in India, and are still as workers at home. Dr. Falconer was one of the first botanists who visited Cashmeer and Little Tibet, where he formed magnificent collections, as he also did in Kumaon and the Punjab, illustrating his specimens with voluminous notes and details of their structure. His collections are, we believe, still in the India House, where they have been for many years. They constitute the only herbarium of importance to which we have failed to procure access, and we are hence unable to do our friend that justice in the body of this work to which, as the discoverer of many of the plants described, he is pre-eminently entitled.'[1] It may be added, that since his death Dr. Falconer's voluminous botanical notes, with 450 coloured drawings of Cashmeer and Indian plants, have been deposited in the Library at Kew.

But his main work during his residence at this time in England was the determination and illustration of the Indian fossils in the British Museum and in the East India House. Captain Cautley, in 1840, had presented his vast collection, the result of ten years' unremitting labour and great personal outlay, to the British Museum, the Geological Society having declined to accept it, as it was beyond their means of accommodation. Its extent and value may be estimated from the fact that it filled 214 large chests, the average weight of each of which amounted to 4 cwt., and that the charges on its transmission to England alone, which were defrayed by the Government of India, amounted to 602*l.* Dr. Falconer's selected collection was divided between the India House and the British Museum; the great mass was presented to the former, but a large number of unique or choice specimens required to fill blanks or improve series were presented to the latter.[2] Other collections of the

1 'Flora Indica.' By J. D. Hooker, M.D., and Thos. Thomson, M.D. Lond. 1855, pp. 67–8.

2 All the specimens in the India House collection which were figured in the 'Fauna Antiqua Sivalensis' were subsequently removed to the British Museum.

Sewalik fossils had been presented to the Museum of the Edinburgh University by Colonel Colvin, and to the Oxford University by Mr. Walter Ewer. The bulk of the specimens in the British Museum were still unarranged and embedded in matrix. In July 1844, a memorial, signed by the Presidents of the various Scientific Societies,[1] was presented to the Court of Directors of the Hon. East India Company, pointing out the desirability of having the specimens in the National Collection prepared, arranged, and displayed, and also of publishing an illustrated work, which would 'convey to men of science in both hemispheres a knowledge of the contents of the Sewalik Hills,' and suggesting Dr. Falconer as the person most fitted to superintend the preparation and arrangement of the specimens and to edit the work. At the meeting of the British Association held at York in the following October, a committee, consisting of the President of the Association with the President of the Royal and Geological Societies, &c., was appointed to memorialize Her Majesty's Government with the same object. Sir Robert Peel, then at the head of the Government, responded to this appeal by making a grant of 1,000*l.* to prepare the materials in the British Museum for exhibition in the Palæontological Gallery. Falconer was in December, 1844, entrusted with the superintendence of the work, and rooms were temporarily assigned to him by the Trustees of the British Museum. The Court of Directors also of the East India Company liberally employed him on duty, on the footing of service in India; and at his instance they caused to be prepared a series of coloured casts of the most remarkable of the Sewalik fossil forms, sets of which were presented to the principal Museums of Great Britain and Europe.[2] Under the patronage of the Government and of the East India Company, each of which subscribed for forty copies, an illustrated work was also brought out, entitled 'Fauna Antiqua Sivalensis.' The work was to have appeared in twelve parts, and six years were calculated as the time necessary for its

[1] The Marquis of Northampton, President of the Royal Society; Lord Auckland, President of the Asiatic Society; Henry Warburton, Esq., M.P., President of the Geological Society; Mr. (now Sir Roderick) Murchison, President of the Geographical Society; Dr. Buckland, &c.

[2] The Museums were those of the Universities of Oxford, Cambridge, and Edinburgh; Trinity College, Dublin; the Royal College of Surgeons; Paris, St. Petersburgh, Copenhagen, Stockholm, Vienna, Berlin, Bonn, Munich, Florence, Rome, Leyden, Brussels, Calcutta, and Bombay.

completion; but within three years there appeared nine parts of the work, each containing twelve folio plates, executed in a style of lithography rarely, if ever, equalled. Mr. Ford, the artist to whom the work was so much indebted, bestowed in several instances as much as 180 hours upon a single plate. No fewer than 1,123 specimens are figured in these plates; and of many specimens three, four, or five different views are given. Besides the Sewalik fossils proper, the 'Fauna Antiqua' includes illustrations of a very valuable and important series of mammalian remains from the Pliocene deposits of the Valley of the Nerbudda, together with illustrations of the Miocene fauna of the Irrawaddi and of Perim Island in the Gulf of Cambay. The descriptive letter-press unfortunately did not keep pace with the plates. After a little progress, Dr. Falconer 'found that the labour in comparing and identifying the enormous mass of materials was so great and the references to be consulted so numerous, that, if he had given up his time to the letter-press, he would have been unable to finish the preparation and arrangement of the collection in the British Museum during the period within which his stay in England was, by the rules of the Indian service, peremptorily limited.' In December, 1847, he was compelled to return to India, where he found it impossible to continue the work, as he had hoped, at a distance from the specimens. On his return to England in 1855, many of the unpublished plates[1] had been erased from the stones on which they had been drawn, and many of the original subscribers were dead, so that the work could only have been continued under extraordinary difficulties. It was Dr. Falconer's intention, nevertheless, to have completed it, and in October 1856, he applied to the Trustees of the British Museum for accommodation and access to the specimens, to enable him to carry out this object. Bad health, however, which compelled him to seek a warmer climate, and his ambition to master every detail connected with the fossil mammalian fauna of Europe, before proceeding to generalize on that of the Sewalik Hills, caused him to postpone its execution until it was too late. To collect

[1] Proof copies of seventeen of these plates, together with outline tracings for the remaining plates of the work, have been deposited in the Library of the British Museum. (See vol. i. pp. 538, 554.)

and arrange the notes which he left behind has been the endeavour of the Editor of these volumes. The great Indian fossil collection, mainly the gift of Sir Proby Cautley, but the specimens of which, unique in their richness, stupendous size, and fine preservation, were prepared, identified, and arranged by Falconer, has long constituted one of the chief ornaments of the Palæontological Gallery of the British Museum. There it may be well said of Falconer and of Cautley: 'Si monumentum quæris, circumspice.'

In June 1847, on the retirement of the late Dr. Wallich, Dr. Falconer was appointed his successor as Superintendent of the Calcutta Botanic Garden, and Professor of Botany in the Medical College; but for six months, at a considerable pecuniary sacrifice, he continued to prosecute his work in connection with the 'Fauna Antiqua Sivalensis;' and it was not until December 20, when a longer delay would have 'involved the forfeiture of his commission and his right to a pension,' that he left England. In February, 1848, he entered upon his new duties in Calcutta, and became at once the referee and adviser of the Indian Government and of the Agricultural and Horticultural Society on all matters pertaining to the vegetable products of India. In 1850 he was deputed to the Tenasserim Provinces, to examine the Teak forests, which were threatened with exhaustion from reckless felling and neglected conservation. His report, suggesting remedial measures, was published in 1850 in the 'Selections from the Records of the Bengal Government,' and is a model of clearness and preciseness on the subject of which it treats.[1] In 1852 he published, in the 'Journal of the Agricultural and Horticultural Society of India,' a paper on the quinine-yielding Cinchonas and on their introduction into India; and in the following year the writer of this sketch saw in the Calcutta Botanic Garden a Wardian case containing specimens of *Cinchona Calisaya*, in which Falconer took great interest. Dr. Falconer was not at the time cognizant of Weddell's accurate determination of the species of Cinchona; but he recommended a trial of them in India, and indicated the hilly regions in Bengal and the Neilgherries in Southern India as the most promising situations for experimental

[1] See List of Botanical Memoirs and Reports, at page lvi, No. 17.

nurseries. The subject was taken up some years afterwards; the bark-yielding Cinchonas were then introduced from South America, and they are now thriving and promise to be a new source of wealth to India. From what has been stated, it will be seen that Falconer was not only instrumental in rescuing from destruction the Teak forests of Tenasserim, but in introducing the cultivation of Tea and Cinchona Bark into our Indian Empire. During his residence in Calcutta, Dr. Falconer communicated to the Agricultural and Horticultural Society many botanical and other reports of great economic value, among which may be mentioned those on 'The Woods for Railway Sleepers in India,' on 'The Timber Trees used for Fuel,' on 'The best means of Tapping the Caoutchouc Tree of Assam,'[1] and on 'The Wild Cochineal insect of Assam.'[2] He was likewise employed in the selection and arrangement of the illustrations of the Botanical products of Bengal forwarded to the Great Exhibition of 1851; and he was the author of the Report on Cashmeer Shawls which appeared in the Official Catalogue.[3] In 1854, assisted by his friend the late Mr. Henry Walker, Professor of Physiology in the Medical College of Calcutta, he undertook a descriptive catalogue of the fossil collections in the Museum of the Asiatic Society of Bengal, which was published as a distinct work in 1859.[4] The labour which this involved was immense. No separate record had been kept by the Society of the numerous presentations of fossils which had been made to it from time to time, and the specimens from different localities were mixed up in the most hopeless confusion. Fossil bones from the Lias of England, from the Cape of Good Hope, Ava, Perim Island, the Valley of the Nerbudda, and the Sewalik Hills were huddled together in heaps in various rooms, and in ninety-nine cases out of a hundred without a label or mark of any kind to indicate whence they came. Dr. Falconer's familiarity with the characters of the fossils from different sources in India enabled him to convert what was little more

[1] See List of Botanical Memoirs and Reports at page lvi.

[2] Journ. Agr. Hort. Soc. of India, vol. vii. p. 33.

[3] Offic. Descript. and Illust. Cat., vol. ii. p. 934.

[4] Descriptive Catalogue of the Fossil Remains of Vertebrata from the Sewalik Hills, &c., in the Museum of the Asiatic Society of Bengal. Calcutta 1859. 8vo. p. 261.

than a chaotic heap of rubbish into a collection of fossils accurately identified and worthy of the Capital of India. In this work he pointed out the distinguishing characters of the matrix of the fossils from different parts of India, as follows:—

1. Those from Ava are black and heavy, and often strongly impregnated with hydrate of iron.

2. Those from Perim Island are usually embedded in a yellow marly conglomerate.

3. The matrix of the Nerbudda specimens is white, soft, friable, and adhering to the tongue, without any ferruginous or calcareous infiltration.

4. The majority of the Sewalik fossils are embedded in a hard sandstone matrix, but others are black, heavy, impregnated with iron, and scarcely distinguishable from the Ava specimens.[1]

As a teacher of botany in the Medical College, Falconer was eminently successful and always a great favourite with his pupils. His house in Garden Reach will long be remembered for the hospitality dispensed to the many who were reckoned among his friends, and particularly to young officers on their first arrival in India. In the spring of 1855 he retired from the Indian service, and on his return home he visited the Holy Land, whence he proceeded along the Syrian coast to Smyrna, Constantinople, and the Crimea, during the siege of Sebastopol.

On his arrival in England he at once resumed his palæontological researches, and in 1856 he published an essay to vindicate the principle propounded by Cuvier, that the laws of correlation which preside over the organization of animals is the guide to the reconstruction of extinct forms.[2] His time was now mainly occupied in studying the fossil species of Mastodon, Elephant, Rhinoceros, and other Mammalia,

[1] The writer has received the following note from Sir Proby Cautley on a fossiliferous stratum lying below the great sandstone and shingle deposits of the Sewaliks:—'The Kalowala Pass deposit of clay-marl in which the small black (hydrate of iron) fossils were found in such numbers by me, and which Durand also found north (or on the Himalayah side) of Nahun is a totally different one from that in which the larger fossils were found in the upper sandstone strata, and lying on the surface amongst the detritus of the sand rocks.'

[2] On Professor Huxley's attempted refutation of Cuvier's Laws of Correlation in the reconstruction of Extinct Vertebrate forms.—'Annals and Magazine of Nat. Hist.,' June 1856.

and the Cave fauna of England and of the Continent. With this object he visited and examined for himself almost every museum and private collection of any note not only in England, but in France, Italy, and Germany, and took careful and detailed notes upon the spot of all the more important specimens. The winters and spring of 1858, 1859, and 1860-61, which he was obliged to spend in the south of Europe on account of his health, were devoted to a study of the valuable collections in the Museums of Lyons, Montpellier, Italy and Sicily; and in the autumn of 1863, in company with his friend M. Lartet, he visited the various collections of fossil remains of Rhinoceros and Cervus in Chartres and Puy-en-Velay. In 1857 he communicated to the Geological Society two memoirs 'On the Species of Mastodon and Elephant occurring in the fossil state in England.'[1] In these essays he attempted to discriminate with precision the Mastodon of the Crag (*M. Arvernensis*) from *M. longirostris* and *M. angustidens*; and to prove that three British fossil Elephants, *E. primigenius*, *E. antiquus*, and *E. meridionalis*, had till then been confounded under the name of *E. primigenius*. So far as materials were available he showed the range of existence geographically and in time of each of these species, and the mammalian fauna with which each was associated. He likewise produced a synoptical table showing the serial affinities of all the species of the Proboscidea, fossil and living, then known, of the former of which a large number had been either discovered or determined by himself. In 1845, at the meeting of the British Association at Cambridge, Dr. Falconer had endeavoured to prove by specimens of crania and teeth, that there was a continuous passage between the Mastodons and Elephants, the forms included by Clift under *M. Elephantoïdes* constituting the connecting links. This view was further developed in the published plates of the 'Fauna Antiqua Sivalensis' and in the two memoirs just referred to. He was the first to establish the constancy of the Ternary and Quaternary ridge-formulæ in the Mastodons, as a means of ranging all the known species under the two natural groups of *Trilophodon* and *Tetralophodon*; and he extended the same principle of

[1] See vol. ii. pp. 1, 76.

the ridge-formula to the arrangement of the rest of the Proboscidean forms, or Elephants, under the divisions of *Stegodon*, *Loxodon*, and *Euelephas*. In 1858 he urged upon the Palæontographical Society the propriety of 'bringing out a series of figures of the natural size and with descriptions of all the teeth of each species of fossil Elephant and Mastodon found in the British strata, so that, wherever a specimen might be discovered, there might be a standard figure by which any competent observer might be able at once to identify it.'[1] In 1862 Dr. Falconer communicated to the British Association at Cambridge an account of *Elephas Melitensis*, the pigmy fossil Elephant of Malta, discovered with other extinct animals by his friend Capt. Spratt, C.B., in the ossiferous cave of Zebbug. This unexpected form presented the Proboscidea in a new form to naturalists.[2] Further researches on general questions concerning the same family appeared in a memoir on *Elephas Columbi*, published in the 'Natural History Review' for 1863, the title of which but inadequately indicated the range of the subjects discussed.[3]

His researches on the fossil species of *Rhinoceros* were scarcely less important. Among many notes and papers which never appeared during his lifetime may be mentioned a most important memoir 'On the European Pliocene and Post-Pliocene Species of Rhinoceros.'[4] In this memoir it is attempted to be shown that there are four distinct Pliocene and Post-Pliocene species of Rhinoceros, three of which have long been confounded by Cuvier and other Palæontologists under the name of *R. leptorhinus*. One of these, the original *R. leptorhinus* of Cuvier, founded upon the Cortesi cranium (*R. megarhinus*, Christol), has no bony nasal septum; two, *R. Etruscus*, Falc., and *R. hemitœchus*, Falc. (*R. leptorhinus*, Owen), have a partial bony septum; while the fourth, *R. antiquitatis*, Blumb., or *R. tichorhinus*, Fisch. and Cuv., has the bony septum complete.

Soon after his return to England Dr. Falconer devoted much study to the new Purbeck mammalian genera discovered by Mr. Beckles, near Swanage. The specimens were

[1] Letter to J. Bowerbank, Esq., Sec. Pal. Soc., March 23, 1858.
[2] See vol. ii. p. 292.
[3] See vol. ii. p. 212.
[4] See vol. ii. p. 309.

subsequently transferred to Mr. Owen for description; but, in 1857, Dr. Falconer published an account of one of these remarkable Purbeck genera, Plagiaulax, and this was followed, in 1862, by a second paper on the disputed affinities of the genus.[1]

Having occupied himself during several years with the special investigation of the Mammalian fauna of the Pliocene, as distinguished from that of the Quaternary period of Europe, he was conducted to the examination of the Cave fauna of England. In 1860 he communicated a memoir to the Geological Society on the Ossiferous Caves of Gower explored or discovered by his friend Colonel Wood, of Stout Hall.[2] The existence of *Elephas antiquus* and *Rhinoceros hemitœchus* as members of the Cave fauna was then for the first time established, and the age of that fauna precisely defined as posterior to the Boulder-clay, or period of the Glacial submergence in England. At the time of his death he was busily engaged in collecting materials for memoirs on the fossil remains of *Cervus*, *Hyæna*, *Spermophilus*, and other genera.[3]

In 1860, while on a visit to Torquay, he was induced to examine the vegetable fossils of the Bovey Tracey Coal, for which he was prepared by previous researches on the vegetable fossils of the Burdwan Coal in India,[4] and he was led to the conclusion that the Bovey Coal, which for twenty years had vibrated in the minds of geologists between Eocene and Post-Pliocene, belonged really to the Miocene and was in correlation with the Coal formations of Germany and Switzerland.[5] This opinion was confirmed by the more detailed investigations of Professor Heer, the results of which were embodied in a memoir presented to the Royal Society in 1862.

While exploring the Himalayahs in his early days, Falconer's attention had been closely directed to the physical features which distinguished them from mountain ranges in temperate regions, and more especially to the general absence from their southern valleys of the great lakes so common in corresponding situations in the Alps. When the hypothesis

[1] See vol. ii. pp. 408, 430.
[2] See vol. ii. p. 498.
[3] See vol. ii. pp 452 to 481.
[4] See List of Botanical Memoirs and Reports at page lv, No. 2.
[5] Letter to His Grace the Duke of Argyll, April, 1860.

of the excavations of lake-basins by glacial action was brought forward, he took a share in the discussion, and combated the view by an appeal to the contradictory evidence furnished by the Himalayahs, the lakes of Lombardy, and the Dead Sea. In connection with this subject it may be mentioned that his last public act—the last occasion in fact in which he left his house—was to attend the Council meeting of the Royal Society, with the object of advocating the grant of 100*l.* to Sir Henry James, for accurately determining by levelling the amount of depression of the Dead Sea below the level of the Mediterranean, an object which since Dr. Falconer's death has been accomplished.[1]

In 1861 Dr. Falconer gave important evidence before the Royal Commission appointed to inquire into the sanitary condition of India. He distinguished between the removable and the irremovable causes of disease, and under the latter he ranked excessive heat and excessive moisture as telling most on the health. He expressed the opinion that fever often resulted from malaria produced by vegetable decomposition.

For nearly thirty years Dr. Falconer had been engaged more or less with the investigation of a subject which has lately occupied much of the attention both of men of science and of the educated classes generally, viz. the proofs of the remote antiquity of the human race. In 1833, fossil bones procured from a great depth in the ancient alluvium of the Valley of the Ganges in Hindostan were erroneously figured and published as human. The subject attracted much attention at the time in India. It was in 1835, while the interest was still fresh, that Dr. Falconer and Captain Cautley discovered the remains of the gigantic Miocene fossil Tortoise of India, which by its colossal size realized the mythological conception of the Tortoise which sustained the Elephant and the World together on its back.[2] In the same formations as the *Colossochelys* the remains were discovered of a smaller Tortoise, identical with the existing *Emys tecta*. About the same time also several species of fossil *Quadrumana* were discovered in the Sewalik Hills, one of which was thought to have exceeded the Orang-Outang, while another was hardly

[1] See vol. ii. p. 655.

[2] See vol. i. p. 367.

distinguishable from the living 'Hoonuman' Monkey of the Hindoos. Coupling these facts with the occurrence of the camel, giraffe, horse, crocodiles, &c., in the Sewalik fauna, and with the further important fact that the plains of the Valley of the Ganges had undergone no late submergence, and passed through no stage of glacial refrigeration, to interrupt the previous tranquil order of physical conditions, Dr. Falconer was so impressed with the conviction that the human race might have been early inhabitants of India, that he was constantly on the look out for the upturning of the relics of man or of his works, from the Miocene strata of the Sewalik Hills. In April 1844 he wrote thus to his friend Captain Cautley :— 'Joining the indication given by the Hindoo mythology with the determined fact of the little *Emys tecta* having survived from the Fossil period down to the present day, I have put forward the opinion that the large Tortoise may have survived also, and only become extinct within the human period. *This is a most important matter in reference to the history of man.*' The same view was publicly announced in 1844 at the Zoological Society.[1] In the account of the gigantic fossil Tortoise, which appeared in the joint names of Dr. Falconer and Captain Cautley, the palæontological and mythological bearings of the case are summed up as follows: 'The result at which we have arrived is, that there are fair grounds for entertaining the belief that the *Colossochelys Atlas* may have lived down to an early epoch of the human period and become extinct since.' Ten years later, while investigating the fossil remains of the Jumna, he pointed out that they were 'most promising of results bearing upon the human period.'[2]

In May, 1858, having the same inquiry in view, while occupied with his Cave researches, he communicated a letter to the Council of the Geological Society, which suggested and led to the exploration of the Brixham Cave, and the discovery in it of flint-implements of great antiquity associated with the bones of extinct animals. In conjunction with Professor Ramsay and Mr. Pengelly he drew up a report on the subject, which, communicated in September of the same year to the Councils of the Royal and Geological Societies, excited the interest of

[1] See vol. i. p. 366.

[2] Preface to descriptive Cat. of Fossils in the Museum of the Asiatic Society of Bengal, 1855, p. 7.

men of science in the case.[1] Although, 'loath in the last degree to leave England, having so much unfinished work on hand,' his health compelled him to seek a warmer climate for the winter. He followed up, however, the same object by proceeding to Sicily to examine the ossiferous caves of that island, and he there discovered the 'Grotta di Maccagnone,' in which flint-implements of great antiquity were found adhering to the roof-matrix, mingled with remains of hyænas now extinct in Europe. An account of this important cave was communicated to the Geological Society.[2] Having examined the collection of M. Boucher de Perthes, on his route to Sicily, he was impressed with the authenticity of some of the flint-implements discovered in the Valley of the Somme, and he urged his friend Mr. Prestwich, than whom there is no higher authority in this branch of Geology, to proceed there and investigate the conditions of the case. This led to Mr. Prestwich's celebrated memoir on the flint-yielding Quaternary deposits of the Somme. Thus, in 1859, the subject of the antiquity of the human race, which had previously been generally discredited by men of science, was launched upon fresh evidence. Since then it has been actively followed up by numerous inquirers, and Dr. Falconer himself was contemplating, and had indeed actually commenced, a work 'On Primeval Man.'[3] In 1863 he took an active share in the singularly perplexed discussion concerning the human jaw of Moulin-Quignon; and in the Conference of English and French men of science held in France he expressed doubts as to the authenticity of the specimen, but in that guarded and cautious manner which was characteristic of him. Dr. Falconer's honesty of purpose and love of truth were well exemplified in this controversy. Before proceeding to the Conference he had publicly expressed an opinion unfavourable to the authenticity of the jaw. The results of the first few days of the Conference seemed to be in his favour, and he wrote thus to London: 'I have every confidence from the present aspect of the matter that we shall establish our case. But I am open to conviction, and will give a true and honest verdict to the best of my convictions.' At the close of the Conference, he wrote again in these words: 'In the

[1] See vol. ii. p. 491.
[2] Ib. p. 543.
[3] Ib. p. 570.

long run matters went against us; and I am very glad that they did, as truth alone was our object.' The doubts which he still entertained were set forth in a memoir which he subsequently wrote, but which never appeared in his life-time.[1]

In the spring of 1864 he published a notice on the remarkable works of art by 'primeval man,' discovered by Messrs. Lartet and Henry Christy in the ossiferous caves of the Dordogne,[2] which he had visited himself in conjunction with M. Lartet; during the subsequent summer he was occupied in preparing a memoir 'On the Asserted Occurrence of Human Bones in the Ancient Fluviatile Deposits of the Nile and Ganges, with Comparative Remarks on the Alluvial Formation of the two Valleys';[3] and in September he accompanied his friend Mr. Busk to Gibraltar, to examine caves in which marvellously well-preserved remains of man and mammals of great antiquity had been discovered. Before starting, he drew up, in conjunction with Mr. Busk, a preliminary report on the specimens brought from Gibraltar to this country, which was presented to the meeting of the British Association at Bath. He attached great importance to the results of this expedition; and on his return home he continued to prosecute the examination of the fossil remains of Gibraltar, the results of which he contemplated elaborating, in conjunction with those of his explorations in Sicily, into a separate memoir on the Mediterranean Cave Fauna.[4]

But his labours were at an end. From Gibraltar he hastened home to support at the Council of the Royal Society the claims of Charles Darwin for the Copley Medal. He suffered much from exposure and fatigue, consequent on the breaking down of the diligence on the Sierra Morena, on his return journey through Spain from Gibraltar, so that the inclement winter told with additional force upon a constitution naturally susceptible of cold and weakened by long residence and serious diseases in India. On January 19th, on his return from a meeting of the Council of the Royal Societ[illegible] he felt depressed and feverish. The attack speedily becam[illegible]

[1] See vol. ii. p. 601.
[2] Ib. p. 626.
[3] Ib. p. 632.
[4] Since Dr. Falconer's death, a preliminary report on the Gibraltar Caves, drawn up by Dr. Falconer and Mr. Busk, as a letter to Sir W. Codrington, Governor of Gibraltar, has been pu[illegible] lished in the Quart. Journ. Geol. So[illegible] (see vol. ii. p. 554.) A more detail[illegible] report by Mr. Busk may shortly be e[illegible] pected.

developed into acute rheumatism, complicated with disease of the heart and lungs, which proved fatal on the morning of January 31, 1865. On February 4 his remains were committed to their last resting-place, at Kensal Green, in the presence of a large number of his sorrowing friends and fellow-labourers.

At the time of his death Dr. Falconer was a Vice-President of the Royal Society and Foreign Secretary of the Geological Society. He had been elected a Fellow of the Royal Society in 1845, and in the same year he had been offered the Secretaryship of the Geological Society, which he had been obliged to decline, as his time was fully occupied with the Sewalik collection in the British Museum. Foreign countries had not failed to acknowledge his transcendent merits as a Naturalist. Besides being a Fellow of the Royal, Linnean, Geological, Zoological and Horticultural Societies at home, and a Member of the Asiatic Society of Bengal, he had been elected a Corresponding Member of the Academy of Natural Sciences of Philadelphia (1836), Foreign Member of the Imperial Austrian Society of Agriculture (1840), Corresponding Member of the National Institute of Washington (1840), Corresponding Member of the Royal Academy of Sciences of Turin (1844), Hon. Member of the Natural History Society of Hesse Darmstadt (1846), Hon. Member of the Academia Valdarnese del Poggio (1859), Corresponding Member of the Imperial Society of Emulation of Abbeville (1863), Corresponding Member of the Imperial and Royal Geological Society of Vienna (1863), and Corresponding Member of the Academy of Natural Sciences of Italy (1863).

As an additional proof of the high esteem in which he was held by men of Science, it may be mentioned that, at a meeting held in London on February 25th, 1865, Sir Proby T. Cautley, K.C.B., in the Chair, it was resolved 'to record the great loss sustained by Science in the early death of the late Dr. Falconer, and to perpetuate his name as a naturalist and a scholar by a suitable memorial.'

It was also resolved that this memorial should include a marble bust, to be placed in the rooms of one of the Scientific Societies, or elsewhere, in London, as might be determined.

One of the objects in which Dr. Falconer had taken deep

interest, up to the latest hour of his life, having been the foundation of Fellowships or Scholarships in the University of Edinburgh, to enable deserving students to prolong their studies beyond the usual academical period, it was further resolved to collect funds for the purpose of founding, in that University, a Fellowship or Scholarship in Natural Science, tenable for a limited term of years, and to be called 'The Falconer Fellowship' or 'Scholarship.'

A Committee, including the Presidents of the Royal, Linnean, Geological, Geographical and Ethnological Societies, was at once formed to promote the objects of the 'Falconer Memorial,' by the exertions of which a sum of nearly 2,000*l.* was collected. The marble bust, by Mr. Timothy Butler, has been accepted by the Royal Society, and placed in their rooms; and by a separate subscription another marble bust has been placed at Calcutta in the Museum of the Asiatic Society of Bengal, to the early reputation of which Falconer so materially contributed. Before long the 'Falconer Fellowship' will be founded in the University of Edinburgh, and will be the real monument of the genius of the man whose name it bears.

From what has been said, it is obvious that Falconer did enough during his lifetime to render his name as a palæontologist immortal in Science; but the work which he published was only a fraction of what he accomplished. The amount of scientific knowledge that perished with him was very great; for not only did he die in the prime of life and in the fulness of his power, but he was cautious to a fault; he always feared to commit himself to an opinion until he was sure that he was right; and thus, as too often happens under such circumstances, he constantly deferred publishing his views, and others reaped the credit of observations originally made by him. No scientific man was ever more deeply imbued with the sentiment, so eloquently expressed by Cicero in the following passage, than he.

'Quid est enim temeritate turpius? aut quid tam temerarium tamque indignum sapientis gravitate atque constantia, quam aut falsum sentire, aut, quod non satis explorate perceptum sit et cognitum, sine ulla dubitatione defendere?' (*Cic. de Nat. Deor.* lib. i.)

These volumes, however, will suffice to rescue his name

from any charge of idleness which some, in ignorance, may have attributed to him.

The rapturous enthusiasm with which Falconer prosecuted his favourite researches, as well as the inferences he drew from the teachings of geological science, are made evident by the following extracts from his Note-books and correspondence.

Writing in 1840 of his Sewalik discoveries, he says:—

'What a glorious privilege it would be, could we live back—were it but for an instant—into those ancient times when these extinct animals peopled the earth! To see them all congregated together in one grand natural menagerie—these Mastodons and Elephants, so numerous in species, toiling their ponderous forms and trumpeting their march in countless herds through the swamps and reedy forests: to view the giant Sivatherium, armed in front with four horns, spurning the timidity of his race, and, ruminant though he be, proud in his strength and bellowing his sturdy career in defiance of all aggression. And then the graceful Giraffes, flitting their shadowy forms like spectres through the trees, mixed with troops of large as well as pigmy horses, and camels, antelopes, and deer. And then last of all, by way of contrast, to contemplate this colossus of the Tortoise race, heaving his unwieldly frame and stamping his toilsome march along the plains which hardly look over strong to sustain him.

'Assuredly, it would be a heart-stirring sight to behold! But although we may not actually enjoy the effect of the living pageant, a still higher order of privilege is vouchsafed to us. We have only to light the torch of philosophy, to seize the clue of induction, and like the prophet Ezekiel in the vision, to proceed into the valley of death, when the graves open before us and render forth their contents; the dry and fragmented bones run together, each bone to his bone; the sinews are laid over, the flesh is brought on, the skin covers all, and the past existence—*to the mind's eye*—starts again into being, decked out in all the lineaments of life. "He who calls that which hath vanished back again into being enjoys a bliss like that of creating." Such were the words of the philosophical Niebuhr, when attempting to fill up the blanks in the fragmentary records of the ancient Romans, whose period in relation to past time dates but as of yesterday. How much more highly privileged then are we, who can recall as it were the beings of countless remote ages, when man was not yet dreamt of; not only this, but if we use discreetly the lights which have been given to us, we may invoke the spirit of the winds, and learn how *they* were tempered to suit the natures of these extinct beings. We may contemplate the soil on which they were afterwards to move and breathe, at first reposing under the depths of the ocean, and then raised tranquilly

into the air, or disrupted by measureless forces, and projected in mountain-ranges high into the heavens. All this may we see, and even date the various events with nearly as much certainty in regard to past time, as we now do human occurrences which refer to the period of the Olympiads. For the Almighty Creator, infinitely beneficent in regard to the wants of his creatures, and thrifty in the use of means, has left imperishable monuments and inscriptions of the past operation of his laws, more durable than the pyramids, and more legible than the hieroglyphics of the Egyptian porphyries. He has engraved on our natures, as well as in the record of revelation, "Seek, and ye shall find; knock, and it shall be opened unto you." In the exercise of this high endowment of our nature, we glorify in the highest degree the attributes of our Creator; and who is he that shall dare to say such pursuits are unholy or opposed to the ends of man's being? That person, if such there be, is an anachronism in time, and a traitor to his being. Better that he should never have been, or that he should have lived amidst the darkness of the middle ages, than that he should deck himself out in the pride of ignorance, as in a marriage garment, and mislead the helpless prejudices of the unlearned. Truly that man arraigns the wisdom and beneficence of God, and vilifies the dignity of his own nature.'

Again, in 1854, he wrote thus to a relative:—

'It has never yet been pretended that there has been a divine revelation expounding the knowledge of the natural world. The Almighty has given us reason, and left us, by the adequate exercise of that power, to investigate the laws and order of Creation. Take Astronomy, and see what has been done in it. Is there any educated person now living that believes "that the sun was made to rule by day, and the moon by night," as servile attendants on the earth?—No; not one. Does any one now believe that the sun rolls round the earth?—No. Yet in former times the universal belief of mankind at the present day was denounced as a damning heresy, opposed to the Bible. Geology is now passing through the ordeal that Astronomy did in the days of Galileo. When the ignorant and bigoted fail in reason and argument, they raise the yell of intolerance, and charge the science with infidelity. The odium of the term serves their end for a time, but what follows? The denounced infidel doctrine, after the lapse of a few years, becomes the accepted faith of all mankind, philosophical and religious. When, therefore, in a good cause the imputation of infidelity is raised, one need not be ashamed of it. There can be no two truths in Nature opposed to each other. True religion and true science can never be irreconcileable. As regards the creation of the world, the evidence is as clear that millions and millions of years must have elapsed between the first appearance of life on the earth and the present day, as that

you and I possess eyes and ears, and have a living existence. The difference merely is, that the evidence is not of the same nature. The one is complete; the other fragmentary, but equally significant and strong. For instance, a tooth, or the end of a joint found in a rock, is as conclusive evidence of the former existence of an animal, as if all the structure—skin, flesh, blood, and living limbs—were before us. The only difference is, that in the one case the evidence is cumulative and complete in every detail; while in the other it is fragmentary and inductive; but it is equally clear and conclusive in both. For the Almighty has so ordained that reason can safely reproduce all that has been lost, and restore to the tooth all that was correlative to it in life. But, remember that what I have said here bears solely upon our knowledge of the physical world, and not to doctrines of faith for our moral and religious guidance.'

Lovers of science and they who knew Falconer well can best appreciate his penetrating and discriminating judgment, his originality of observation and depth of thought, his extraordinary memory, his fearlessness of opposition when truth was to be evolved, the scrupulous care with which he awarded to every man his due, and his honest and powerful advocacy of that cause which his strong intellect led him to adopt. They have also occasion to deplore the death of a staid adviser, a genial companion, and a hearty friend.

LIST

OF

BOTANICAL MEMOIRS AND REPORTS.

By Hugh Falconer, M.D., F.R.S.

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1. On the Aptitude of the Himalayan Range for the Culture of the Tea Plant. *Journal of the Asiatic Society of Bengal*, vol. iii. p. 178, April 1834.

2. Plates prepared for the illustration of an unpublished Memoir on the Fossil Plants of the Burdwan Coal-field, intended to have appeared in the 'Asiatic Researches,' 1833–6. [These consist of nine plates engraved on stone, and comprising thirty-three figures. They have been deposited in the Library at Kew.]

3. Description of the Prangos Grass, *Prangos pabularia*, Lind., of [illegible] and Cashmeer. [See vol. i. p. 568.]

4. Report to the Bengal Government on the Cultivation of Hemp in [illegible] Suharunpoor, about 1839.

5. Some account of *Aucklandia*, a new genus of *Compositæ*, believed to produce the *Costus* of Dioscorides. *Transactions of the Linnean Society*, vol. xix. p. 23. Read November 17, 1840.

6. On a reformed character of the genus *Cryptolepis*, Brown. *Transactions, Linnean Society*, vol. xix. p. 53. Read June 15, 1841.

7. On *Edgeworthia*, a new genus of plants of the order *Myrsineæ*. *Transactions, Linnean Society*, vol. xix. p. 99. Read March 15, 1842.

8. Notes on several new genera of Indian Plants, including a new genus called *Enantia*. *Hooker's Journal of Botany*, vol. iv. p. 173. 1842.

9. Description of the *Assafœtida* Plant of Central Asia. *Transactions, Linnean Society*, vol. xx. p. 285. Read November 3, 1846.

10. Account of *Gamoplexis*, an undescribed genus of *Orchid* Plants. *Transactions, Linnean Society*, vol. xx. p. 293. Read February 2, 1847.

11. On Athalamia, a new genus of *Marchantieæ*. *Transactions Linnean Society*, vol. xx. p. 397. Read June 1, 1847.

12. Memorandum respecting Timber Trees and materials used fo Fuel in India. *Journ. of Agric. and Hortic. Society of India*, vol. vi p. 163. 1848.

13. Report on the 'Pooah' of Nepaul and Sikkim, 'Poee' of Gurhwal and Kumaon, the fibre of *Bæhmeria frutescens*. Don. *Urtica frutescens*. *Journ. Agric. and Hort. Soc. of India*, vol. vi. p. 240. 1849.

14. Report on the 'Chú-Má,' or Grass-Cloth Plant of China, and its identity with the 'Kunchoora' of Bengal, and 'Rhiea' of Assam. *Urtica tenacissima*, Roxb. *Journ. Agric. and Hort. Soc. of India*, vii. p. 18. 1850.

15. Report regarding Fruit Trees imported into India from Nor America in Ice. *Journ. Agric. and Hortic. Soc. of India*, vol. v p. 172. 1850.

16. Report on some Soap-yielding Pods of a leguminous plant fron China, allied to *Cæsalpinea*. *Journ. Agric. and Hortic. Soc. of India* vol. vii. p. 280. 1850.

17. Report on the Teak Forests of the Tenasserim Provinces, being No. IX. of 'Selections from the Records of the Bengal Government Calcutta 1852. 8vo. p. 286, with coloured plates and maps.

18. On the Quinine-yielding Cinchonas and their introduction India. *Journ. Agric. and Hortic. Soc. of India*, vol. viii. p. 13.

19. Memorandum on the Victoria Regia Water Lily in the Botanic Garden. By Mr. Robert Scott and Dr. Falconer. *Journ. and Hortic. Soc. of India*, vol. viii. p. 17. 1852.

20. Remarks on *Scævola Taccada*, quoad Rice-paper. *Journ. A and Hortic. Soc. of India*, vol. viii. p. 66. 1852.

21. Remarks on the best mode of tapping the Caoutchouc Tree Assam. *Journ. Agric. and Hortic. Soc. of India*, vol. viii. p. 10 1852.

22. Report to the Indian Government on the best Woods for Railw Sleepers in India.

23. Coloured Drawings of nearly 500 Plants from Cashmeer, Tibet, and Upper India, which, with descriptions of many hundreds of Indian Plants—mainly *Orchideæ*—in manuscript, have been deposited in the brary of Kew.

FAUNA ANTIQUA SIVALENSIS.

I. INTRODUCTION.[1]

BY H. FALCONER, M.D.

A.

TRODUCTORY OBSERVATIONS—ANTIQUITY OF HUMAN RACE IN INDIA —ITS MYTHOLOGY—ANTIQUARIAN CONDITION OF INDIA BEFORE MAN— EVIDENCE AFFORDED BY ORGANIC REMAINS—HISTORY OF DISCOVERY OF FOSSILS IN INDIA.

IE antiquities and literature of the East have been, from its mmencement, the special field of investigation to this So- ty, and to the parent institution in Calcutta. A rich vein s been opened, branching in a thousand ramifications, and tile in results of the deepest interest. The human race been traced farther back into time in the East than in other quarter of the globe; and the tendency of all in- ries has been to show that the civilization of at least a e section of mankind first dawned in the valley of the ges. The language or the mythology, the arts and the nces of India, have all been found more or less engrafted surrounding nations, and even that civilization which we boast of—which has shot so far ahead of the parent stock ay be followed back to a spring-head in India, whence it velled westward through Egypt, and spread over Greece d Italy.

Nor is it remarkable that it should be so. Man, *cæteris aribus*, must have progressed most rapidly where most vourably placed in regard to the external conditions which egulate the increase of his race and the development of his cial relations. Neither the valleys of the Nile, nor of e Euphrates, Tigris, or Oxus, in extent and fertility to- er, or in the richness and variety of their productions,

[1] This introduction is mainly based on the manuscript of two discourses delivered by Dr. Falconer before the Royal Asiatic Society of Great Britain, on June 1 and 8, 1844, a very brief abstract of which only appeared in the Journal of the Society (No. xv. Pt. i. p. 107). Part B., however, was probably written in India some years before; and Part C. has been, in a great measure, constructed by the Editor from private letters written by Dr. Falconer, between the years 1844 and 1847. This will account for the designations of several of the fossils being different from those given in the published abstract.—[Ed.]

can admit of comparison with the valley of the Gang
Sugar, rice, cotton, and the golden fleece of the silkwo
with numerous other industrial products, have from t
remotest antiquity been the common staples of the counti
and have been brought forth in such surprising abundanc
that other less-favoured nations could only embody the id
by conceiving that the sands of India were strewed with gol
So far down even as the days of the Roman empire, we fi
Pliny describing sugar as a kind of honey which exuded nat
rally from reeds in India, like a gum, but assuming the for
of a crystal. To benefit suitably from such favoured circun
stances, we find that the Indian variety of the Caucasia
branch of the human family has the most perfect develo
ment of that physical conformation which is observed to
associated with the highest capability for mental improveme

It is beside my object, on the present occasion, to do m
than barely allude to this line of research and its bearings,
introductory to the subject I am desirous to bring bef
you this evening, which is to take up the antiquarian hist
of the animal races of India, back from the epoch where
lose all indications of mankind.

There is a point up to which we can follow man b
through the records of language and art and the shad
indications of mythology and tradition, but beyond whic
cannot go. Every trace of the human race then fails us;
if we wish to dive further into remote antiquity we hav
fall back on another order of antiquarian research, of
highest interest, resting on monuments and inscriptions
structed by nature, more enduring than the colossal sculp
of Elephanta, as legible as the scroll on the Bactrian c
and infinitely more certain in their indications than langu
tradition, or mythology.

The *Colossochelys Atlas*, or gigantic fossil tortoise of Ind
discovered by Captain Cautley and myself, supplies a fit repr
sentative of the tortoise, which sustained the elephant and th
infant world in the fables of the Pythagorean and Hindu co
mogonies. It is a point of great interest to trace back to a pr
bable source a matter of belief like this, so widely connect
with the speculations of an early period of the human race

You are aware that at the present day every climate a
every great division of the globe are characterized by t
peculiar race of animals. So constant are the laws which
regulate this distribution that, if told of the existence of
certain species, we can predicate with confidence regarding
the temperature of a country, and the general character of
the vegetation with which they are associated. Nature, uni-
form in the operation of her laws, has followed the same

in past time as we observe at present, and thrifty in handiwork, has not merely created and extinguished nerous successions of beings, but at the same time left lelible records of each in the strata which constitute the rface of the globe. We can trace by their fossil remains e different faunas, from the oldest up to the existing creares. The further we go back into antiquity, we find the imated races to differ more and more from what they are present; and as we descend toward the human period, we tect a progressive approach to the existing kinds of beings. he order of succession has been followed out in Europe by ie concurrent labours of a vast number of observers, with onderful precision; and the changes in the animals have en shown to have been accompanied by corresponding alrations of climate, or of other physical conditions. We ive the most certain proofs that England had at one time ie heat of the tropics with a similar vegetation and tropical imals; and there are the strongest grounds to believe that a later period it was either covered with glaciers or eeted over with the drift-ice of an Arctic ocean.

The smaller number of observers in tropical countries has cessarily led to our knowledge in regard to them being initely less advanced than as regards Europe. But much is been done lately in America and in India. Passing over ore remote periods, we shall now proceed to consider what is the condition of the animated creation in the latter untry during the period which preceded the appearance of e human race upon it. When the plains of Europe fed the ammoth, the Elasmotherium, and the Rhinoceros, and nerica the Mastodon and the Megatherium, what were the ids of animals that then peopled India?

The evidences employed in inquiries of this nature, in lieu the monuments and inscriptions used by the ordinary anuary, are the fossil remains of extinct animals found in the ver strata of the earth. But before entering upon them it y be well to say a few words regarding the method upon ich the evidence is worked out. Every organised being is de of a number of parts, which have a definite and conit relation to each other and to the common functions of aggregate form. For instance, a predaceous animal like tiger can only live on flesh; its alimentary apparatus is structed to digest this kind of food; its jaws and teeth formed to act like a scissors in cutting it up; its claws to e its prey and tear it to pieces; its extremities are built nable it to spring; and in connection with the rest, it has instinct which leads it to lie in wait, or come stealthily its victim, and so on throughout its system. On the

other hand, an herbivorous animal has its teeth and jaws
structed to act as a grinding apparatus; its extremities
not required to seize prey, and are, therefore, formed mer
to sustain the body, and for speed to enable it to escape fr
danger; and so on with corresponding modifications throug
out its organisation. In short, every part of an animal bea
an invariable relation to every other part, and is of itself
index to the general form. The bony skeleton constitut
the basis of the construction. When, therefore, fossil bon
are detected in the strata of the earth, each fragment is
monument of the existence of a former race of animals, an
every tooth or articular surface a distinct inscription, as
were, in regard to the special character of the animal fro
which the bones were derived.

The first notice of the occurrence of fossil bones in Indi
is contained in that excellent compendium of the history c
the Moghul and Pathan emperors by Ferishta. We are ther
told, that under the reign of Feroz Shah the Third, in the yea
1360, 'The emperor on his return to Delhi, in the month
Rujub (May 1360), was informed that near Hirdar[1] there was
hill out of which issued a stream of water called Sursoot
running into the Sutlej, and beyond a watercourse calle
Selima. It was stated that if a great mound between thes
two streams were dug through, the water of the Sursoot
would flow into the Selima, and thence through Sirhind an
Mŭnsoorpoor on to Sunnam, and that the supply of wate
would be perennial; whereupon the emperor proceeded i
that direction, and having ordered 50,000 labourers to be as
sembled, he caused the eminence to be dug through, so as
form a junction of the two streams. In course of the oper
tions bones of elephants and men were discovered in
unbedded mound. Those of the human forearm measu
three yards. Some of the bones were petrified, while oth
were still in the condition of bone.[1]

The bearing of this passage upon Indian palæontology
first observed by General Briggs. The locality Hirdar re
to a place in the Sewalik hills, where abundant fossil rema
have been found since.

Captain Webb, in his admirable survey of heights of
Himalayah mountains, was the first to prove the existenc
fossil bones in that chain. They are called 'Bijli ki har,
'lightning bones' from their supposed origin, and are fo
in the elevated plain of Tibet behind the sources of
Ganges. They are collected by the inhabitants, and expo
to the plains as charms. In this way they were brougl
the notice of Captain Webb, who communicated them to

[1] *Perwar*, according to Prinsep.—[Ed.]

brooke, by whom they were sent to Europe. They d to in Dr. Buckland's 'Reliquiæ Diluvianæ,' but ied account of them has yet been published. The portant inferences connected with these remains in to the elevation of the Himalayahs will be noticed er.

next notice of fossil remains in India was by Mr. rd, who during his embassy to Ava, in 1826, dis- a deposit of silicified bones of large animals along ks of the Irrawaddi, consisting of remains of Masto- inoceros, Hippopotamus, Crocodiles, Deer, and other . Such of the species as admitted of identification scribed by Mr. Clift in the 'Geological Transactions,' racted great interest at the time. Mr. Clift established portant fact of the former existence of two species of don peculiar to India.

next discovery of fossil bones was made by Captain ey and myself, in 1831, in that range of tertiary hills ng the foot of the Himalayahs, to which we have applied ame of Sewalik hills.[1] They were at first found spar- , but in increasing numbers up to 1834, when through nation supplied by a native rajah, Lieutenants Baker urand were guided to a tract where they were found in most abundance near the sources of the Sursooti river. in the investigation, in 1835, an account was published very remarkable animal, called the Sivatherium, which ened attention to the subject in India generally; and r remains were found in the valley of the Nerbudda by pilsbury, and in Perim Island in the Gulf of Cambay by ush and Lieut. Fulljames. It is interesting to keep these n mind, as Perim Island, the Irrawaddi, and the western f the Sewalik hills, form as it were three points in a triangle spread over the whole width of India, showing e same ancient race of animals formerly extended over tinent.

note written by Dr. Falconer, 'Fossil bones were first dis- Lt. Cautley. He met with iece which was so imperfect not imagine it to be a por- imal remains. On going to y some years afterwards, I a few fragments which satis- the existence of fossil bones r hill formation. They con- rtions of a testudinous shell, of one of the reptilia, &c. I with some laminar pieces of carbonate of lime, simulating appearance of a compressed bivalve shell, which subsequent examination proved them not to be. A slight notice of the circumstance was given by Dr. Royle in the Journal of the Asiatic Society (vol. i. p. 96). The fragments up to this date were so imperfect, that little beyond conjecture could be made out of them, but during last cold weather, on a visit to the Timli pass, I found a fragment of a well-marked testudinous remain, and since then Lt. Cautley has been so fortunate as to discover several other portions of bone, which set the matter at rest.'—[Ed].

Before entering on the particulars of the fauna well to refer briefly to the geographical relations a logical structure of the Sewalik hills.

B.

ON THE GEOGRAPHICAL POSITION, PHYSICAL CHARACTERS, AND GE STRUCTURE OF THE HYSUDRO-GANGETIC PORTION OF THE SEWA IN NORTHERN HINDOSTAN.

By 'Sewalik hills,' it is here meant to designa range of lower elevations which stretches along t foot of the Himalayah mountains, for the greatest po their extent from the Indus to the Brahmapootra, whe rivers respectively debouche from the hills into the pl India. The name Sewalik,[1] or Scevalik, has hitherto definite application, nor has it been universally adopt the geographers of India. By some it has been restric the tract between the rivers Jumna and Ganges; by otl that between the Ganges and Gogra forming the plain- boundary of the province of Kumaon; and by others to between the Gogra and Gunduck forming the northern dary of the province of Oude; while in Arrowsmith's M 1816, and in the 'Grand Trigonometrical Survey Ma designation is nowhere applied. We have resorted t term Sewalik as geognostically preferable to Sub-Himala which were equally applicable to a range at the northe at the southern foot of the great chain: the ambiguity inconvenience of a term of this sort having been felt i restricted use of 'Sub-apennine.' Sewalik is also conv as a geographical designation; and its having been a by various authorities to different portions of one range, wise without a name, is a sufficient reason for its adopti the whole of that range.

Special object of the Memoir.—The object of this mei

[1] Sewalik, or Scevalik, derived from Siva, or Mahadeo the Hindoo God: these hills, as well as the Himalayahs being connected in Hindoo mythology, in various ways with the history of Siva. Major Rennell (Memoir, p. 72) applies the name to the tract from the Sutlej to Hurdwar (p. 233).

Rennell, describing the Ganges (3rd edit. 1793, p. 313), says, 'At Hurdwar it (the Ganges) opens a passage through Mount Sewalick, which is the chain of mountains that borders on the level country on the north of the pr Delhi. Even Sewalick would a lofty range, but for the p Mount *Himmalch* or *Imaus*, above it, when viewed from t Hindostan.'

Idem, p. 368. 'Sirinagur is an exceedingly deep, and v valley, formed by Mount Sew northern boundary of Hindoos one side, and the vast range of or *Imaus* on the other,' &c.

* Sewalik is the term according to the common acceptation; but Captain Kirkpatrick proves, from the evident etymology of it, that it should be *S* RENNELL, p. 368.

to illustrate that portion of the Sewalik hills extending from the Hysudrus or Sutlej, on to the Ganges, which has lately yielded an immense quantity of the fossil remains of a variety of new species of mammalia. This is the only part of the range which we have been able to examine, but for an exposition of its geological relations it will be necessary to notice the extent of the tract north-west and south-east of this portion.

Range and Extent.—The Sewalik hills appear to commence near the western bank of the Jhelum or Hydaspes, about E. long. 74°, and to run down to the eastward of the Gunduck in E. long. 85°, along an extent of at least 11°. It is probable that they are prolonged to the eastward in the Lohara Dunga range, till they are lost in the marine formations of Assam. From long. 74° to 82° the direction is about NW. and SE. To the eastward of 82° they bend so as to run almost due E. and W. Their axis is parallel to that of the great chain of the Himalayahs, and in the examined portion the strata have the same direction and dip. They are intersected along their whole line, at short intervals, by the numerous streams which unite to form the two great extra-montane river systems of drainage for the Himalayahs, that of the Indus to the west and of the Ganges to the east, the Brahmapootra being intra-montane along its entire course.

Extent of the known Tract.—The tract along which we have examined these hills from the Sutlej at Roopur, long. 76° 30′, to the Ganges at Hurdwar, 78° 10′, although considerable in itself, is small for the extent assigned to them; and some doubt might be entertained of the identity of the range along so protracted a line. But their physical and geographical characters are so marked, that a glance at the map would alone be convincing. Besides, from the hills at the eastern bank of the Sutlej, near Roopur, we have seen them stretching far off into the Punjab with the same north-westerly direction, and with a continuity interrupted only by the bed of the river; and in the same way they are seen from the heights at Hurdwar, running out of sight to the eastward as they skirt the hill province of Kumaon. Mr. McClelland[1] also gives a section and description of the Sub-Himalayan heights near the Gogra, long. 80° 20′, which show that Sewalik hills there are formed of the same beds, and attain similar heights as in the tract between the Jumna and Ganges. We are therefore certain of their geological identity along a line of 4° of longitude, or of about 272 miles. Captain Herbert[2] has also described them at the outlets of the Ramgunga and Cossillah rivers, as showing the same characters as at Hurdwar, and imagines the

[1] Geology of Kumaon.

[2] Herbert, Mineralogical Report, MSS. p 316.

same formation to extend from beyond Cashmeer to Patna, with valleys along the whole line.[1]

From our researches, we have been led to the opinion that the whole line of the Sewalik hills extending from the Indus nearly to the bay of Bengal, and formed by the débris of the Himalayahs, transported by the same causes acting under the same circumstances as at present, has been broken up from the plains of Hindostan and assumed its present Alpine characters within a very late geological epoch, posterior to the long establishment upon the north of India of animals so highly organised as the Quadrumana, of species of Camel, Ox, and Antelope, and of Crocodiles now existing in India. The importance and imposing character of the deductions demand a rigid investigation; and with the risk of being considered tedious and discursive, before entering on the Geological details of the formation, we shall prefix a sketch of the Physical characters of the neighbouring plains of Hindostan, and of the conterminous Himalayah chain.

The course of the Nerbudda, in lat. 23° to 24° N. naturally and geognostically divides the continent of India into two great portions: the southern or hilly, and the northern or 'plains of Hindostan.' The former is surrounded on all sides by distinct Alpine ranges, disposed pretty nearly in the form of a triangle; with the Great Vindhya range running E. & W. for its base, and the eastern and western Ghats for the sides. The two latter meet in the apex at the southern extremity of the continent near Cape Comorin, and at their northern limits they join on respectively with the eastern and western extremities of the Vindhya chain. From the western and central portion of the latter, subordinate ranges such as the Aravalli are sent off to the north, jutting into the division of the plains. The northern portion, or plains of Hindostan, is composed of the two great extra mountain basins of the river systems of the Himalayahs, the Ganges and Indus. These form two great alluvial plains. The one commencing in the delta of the Ganges and Megna stretches NW. from the Bay of Bengal in 22°, to the Guggar in lat. 31°, in one unbroken flat included between the Himalayahs on the NE. and the northern extremity of the eastern Ghat on the west, beyond which it expands to the west behind the Vindhya chain. The other commences in the delta of the Indus, and stretches north and east as marked by the five rivers of the Punjab, to the foot of the Himalayahs. The two basins are conterminous about halfway between the Jumna and Sutlej in lat. 30°, where they

[1] Herbert, p. 69, para. 57. Para. 284 and 285.

intermingle in one continuous flat, and with no hilly ridge intervening; and they stretch united across the continent through the plains of Hurrianah and the sandy desert beyond.

From the mouths of the Ganges up to the northern extremity of the Doab,[1] the Gangetic valley gradually rises, till at Suharunpoor it attains the height of 1,000 feet above the level of the sea, after a stretch of about 1,200 miles. The gulf of Scinde is about equi-distant from the same point, and the slope of the plains in that direction across the continent may be considered the same. In the north-western extension of the plains which form the basin of the Indus there appears to be no considerable elevation above the northern limit of the Gangetic valley, as without any mountain barrier to alter their direction the rivers converge to the west to flow into the Gulf of Cutch; and when they are conterminous, the Soamb, a branch of the Indus system, crosses the line of a canal, one branch of which runs towards the Indus and the other to the Bay of Bengal.

Himalayah Chain.—The Himalayah mountains bound the whole extent of this immense plain on its north-eastern side. This mighty chain, in all its features, is the grandest accumulation of mountain masses on the surface of the globe. Its lofty pinnacles, so long the subject of controversy, not only surpass all others in individual peaks, but maintain their overtowering elevation along lines of hundreds of miles. They are covered with vegetation where analogy would mantle them with snow. They embosom within their belt extensive plateaux or valleys abounding in numerous races, and covered with the works of man, as high as the loftiest peaks of Alps. Their rivers water the most fertile regions of the earth; their accumulated débris has formed a continent which supports a population equal to half of that of Europe. They separate two of the most densely peopled and distinct sections[2] of the human race, each of which claims for itself and the mountains above them a remoteness of antiquity reckoned only by millions of years; and so effectual a barrier do they oppose, that these races but a hundred miles apart are less known to each other than they are to [illegible]e nations of Europe, divided from thence by thousands of [illegible]iles of ocean.

Explored portion.—What of them is at all well known [illegible] but a limited tract included between the rivers Sutlej and [illegible]ogra, a line of about 270 miles; and here the scientific [illegible]abours of Hodgson, Herbert, Webb, and the Gerards, have [illegible]een so successful that the physical outlines of the mountains

[1] Mesopotamia of Hindostan.

[2] The Mongolian and Caucasian races.

have been as well laid down as any equal extent of Alpine tract in Europe.[1]

All westward from the Sutlej to the Indus is unexplored, and the same may be said of the tract from the Gogra to the Bay of Bengal.

One or other of us, Captain Cautley or myself, has had opportunities in repeated journeys of examining that portion of the mountains between the Ganges and the Sutlej. These journeys have extended as far as the sources of the Ganges and Jumna, and have intersected the lower tracts of mountain in various directions. As the chain possesses a great deal of uniformity of outline and physical characters generally, for nearly 1,000 miles, it may safely be presumed that the geognostical relations of the mountain masses, as exhibited in the tract we have examined, may be taken as a type of the whole; excepting the western prolongation along the valley of Cashmeer, where fossiliferous limestones are found. Further we have not had an opportunity of examining the fossiliferous limestones on the northern or Tartary slope.

As we attribute the formation of the whole line of the Sewalik hills to the alluvial degradation of the Himalayahs, we shall make no apology for entering at some length on their physical outline, river systems, and geological structure.

The Himalayah mountains are generally described as commencing in long. 75°, lat. 35°, where they join on with the Hindoo Koosh, and run down to Bootan, long. 90°, a course of 1,500 miles, skirting the plain of Hindostan. Their line of direction from the Indus is about from NW. to SE. South of the Gogra they get more easterly.

They form one of the mountain boundaries of an elevated

[1] We especially particularise the late Captain Herbert, who, besides an important share in the Trigonometrical labours of the Survey, investigated with great zeal the Geological and Mineralogical characters of the whole tract, and furnished a voluminous report to the Indian Government on the subject. Unfortunately, Captain Herbert was a self-taught and book geologist, and he was called upon to describe the geology of an unknown field—a subject new to him, at the very time when he was acquiring his first knowledge of geological science. The consequence is, that his labours have been less valuable than they otherwise would have been from his talents and general scientific acquirements with longer study. He has fallen into several important errors. He has described as gneiss an enormous protrusion of granite which forms the axis of the snowy range —shown in a colossal section across many miles, near the sources of the Ganges; and he has fallen into the same error with regard to a porphyritic trap, which forms a most important member of the Himalayan rocks. He has restricted the rock formations to granite and gneiss, and attached minor importance to [redacted] enormous formation of primary sa[redacted] stone. We have been favoured lat[redacted] with a perusal of his manuscript rep[redacted] *unpublished*, and in consequence, in wr[redacted] ing on the same subject, we deem it n[redacted] cessary to notice the above, while o[redacted] numerous references to his report t[redacted] how largely we have drawn from it.*

* Captain Herbert's Report was published as an appendix to vol. xi. of the Journal of the Asiatic Society.—[Ed

central tract from which all the great rivers of Asia radiate; on the Indian side their drainage being effected by the three great systems of the Indus, Ganges, and Brahmapootra. The most remarkable feature about the Himalayahs is a line of snowy peaks which may be considered as forming the axis of the chain, a plain supported on which, from Cashmeer to the Delta of the Ganges, would be elevated upwards of 20,000 feet above the level of the sea. Between this central range and the plains of Hindostan there is a belt of mountains of minor altitude, with an average elevation of about 7,000 or 8,000 feet. These intermingle with the Sewalik range, which rises abruptly from the plains.[1]

* * * * *

The great chain of the Himalayahs rises in a ridge with an abrupt steep face against the plains of about 6,000 feet in height; there is then a slope from the crest of the ridge towards the north. This is the general character of the Himalayahs. The mountains on the side of the snowy range consist of a series of nearly parallel ridges, with intermediate valleys or hollows. They throw off spurs in all directions into the hollows, forming subordinate valleys. There is nothing like table-land (perhaps in the whole of the mountains, with the exception of Nepaul), and the valleys are rather broad, wedge-shaped chasms, contracted at the bottom to a mere water-course, than anything else; in fact, the ridges and intermediate valleys, as a general law, form a series of salient and re-entering angles, as seen in the sketch (fig. 1, p. 19). In consequence, the quantity of level or nearly level ground to be met with is most inconsiderable. From the dip or slope being towards the north, and the abutment to the south being steep, the great mass of vegetation has a northern exposure, and the southern faces of the mountains are generally naked.

The formations are primary; the first towards the plains consist of vast strata of limestone, lying on clay-slate, crowned by slate, greywacke, or sandstone. Beyond the limestone tract, gneiss, clay-slate, and other schistose rocks, occur. Granite, so far as I know, is not found in the outer ridges. It occurs in the mountains nearer the snowy range. I have not gone so far, and have not yet seen granite *in situ*. The igneous rocks, which have been concerned in the upheavement of the outer tracts, are of the green-stone trap series, and are very generally met with in dykes intersecting and rising through the regular strata. The formations

[1] The manuscript here breaks off abruptly. The three paragraphs which follow are extracted from an essay by Dr. Falconer, 'On the Aptitude of the Himalayan range for the Culture of the Tea plant' (Journal of the Asiatic Society, April, 1834).—[Ed.]

have a remarkable feature. The strata are in all directions fractured or comminuted; the slaty rocks are broken into small fragments, as if they had been crushed; and the limestone rocks are vesicular or cavernous, and broken up into masses.

The arrangement and nature of the soil take their character from the rocks. From the high angle at which the latter are inclined, and the northern direction of the slope, the soil is chiefly accumulated on the northern sides, where is also the vegetation. From the presence of schistose strata and limestone, the soil underlying the vegetable mould is clayey and calcareous, or limestone gravel. There is little sandy soil or sandy gravel. From the extreme richness of the vegetation, undisturbed for ages, and the moisture of the climate, there is usually a great accumulation on the northern slopes of vegetable mould; on the southern faces, the great steepness leaves little room for the accumulation of soil; where it occurs it is in patches, and consists of clays or limestone gravel, mixed up with vegetable mould. There is here also little sandy soil. Towards the crest of the slopes the soil is usually dry, from the moisture running speedily off; but lower down, and wherever the ground is tolerably level, the soil is quite damp, and perhaps it is rarely dry in the most parching seasons.[1]

* * * * *

The Himalayah mountains are skirted on the SW. by a range of lower hills which separate them from the plains of India. These commence at Roopur on the Sutlej (see Plate III.), in sandy elevations of inconsiderable height, and run down a long way to the south, following the direction of the great chain. In some places they run up to the Himalayahs, and in others an intermediate valley lies between the two ranges, as that of the Dhoon. On their SW. side, which looks towards the plains, they are bounded by a broad belt of luxuriant Terai jungle. The following observations refer to that portion of the Sewalik hills which lies between the Jumna and Ganges. I have not had an opportunity of seeing them, where they extend to the east and west of the Ganges and Jumna respectively, but there is little doubt that the type of all that extends to the west of the Jumna, and of several hundred miles of the tract of hills to the east of the Ganges, is to be found in what lies between these two rivers.

The geological characters of the Sewalik hill formation possess great interest. They appear to consist of an upheaved portion of the plains of India lying at the foot of the Himalayah mountains. The nature of their mineral contents and depth of the strata give evidence of their having been formed

[1] What follows is another portion of MSS. on the same subject.—[Ed.]

during a comparatively recent geological æra, and of a vast series of ages having transpired during their deposition up to the period of their upheavement. Their coincidence with the great chain of the Himalayahs in parallelism, line of direction, similarity of dip, in contrast with the opposite nature of their rocks, connect them closely with the ingenious speculations of Elie de Beaumont, regarding the æras of upheavement of parallel mountain chains.

The Jumna-Gangetic portion has already attracted the attention of Indian geologists. The first published account of them, so far as I am aware, is by Lieut. Cautley, Superintendent of the Doab Canal, who in vol. xvi. of the 'Asiatic Researches,' has given a very accurate description of the mineral characters of the strata, in connection with the occurrence of coal and lignite, which first attracted his attention. It is to his zeal that we are indebted for the discovery of animal organic remains in the Sewalik hills. Captain Herbert, in the same volume of the 'Researches,' has described the tract from the Sutlej to the Kali rivers, and enters fully on the nature of the coal or lignite met with there. He seems to have formed the opinion that the formation is that of the rock marl or new red sandstone of England. Dr. Govan, in a paper on the Physical Geography of the Himalayahs, has given a brief sketch of the lower hills. He considers them as belonging to the oldest of Buckland's alluvial deposits.[1] The lower hills were examined by Mons. Jacquemont in 1831, but I am not aware that any account of them by him has been published.

The Himalayah mountains north of the valley of Deyra consist of primary stratified rocks, dipping towards the east of north; their abutment is to the south. Their line of direction is from NW. to SE. or thereabouts. The rocks consist chiefly of argillaceous schists and vast beds of limestone. The strata are inclined at a high angle. The mountains here at once rise with an abrupt mural front to about 7,000 ft. above the level of the sea, and 6,000 above the plains in the neighbourhood. No organic remains have as yet been met with in the outer ridges in the tract between the Sutlej and the Ganges, or on this side of the snowy range.[2] Of the unstratified rocks, greenstone traps, which were first, so far as I know, observed by Lt. Cautley, occur in considerable abund-

[1] Brewster's Journal of Science for 1825, vol. ii. p. 32.

[2] In my possession there is a small spiral-chambered univalve, closely resembling a Turritella, which I received from my friend Lt. Vicary, a most zealous and indefatigable traveller in the Himalayahs. Mr. Vicary met with it near Mussooree. The specimen was put by, without the fossil being observed till several days after. Mr. Vicary could not subsequently hit upon the spot where it was found, and as it might have been broken from a boulder, I have, pending the uncertainty about the matrix in which it occurred, attached no importance to the fossil till it should have been met with again *in situ*.

ance, rising in dykes through the stratified rocks, also diallage rock. I am not aware that granite is found in the outer ridges. It occurs abundantly in the Choor mountain. Its place in the outer ranges is occupied by the greenstone traps and diallage.

At the foot of the Himalayahs lies the valley of Deyra, stretching from the Jumna to the Ganges, and bounded on the south by the lower or Sewalik hills. It is situated about 1,400 ft. above the level of the sea. The plains in front of the Sewalik hills are about 1,000 feet above the sea, and stretch up to the foot of the hills with so slight an inclination as to be imperceptible to the eye. The hills rise abruptly from the plains. Their direction is from NW. to SE. parallel with the great chain of the Himalayahs. Their dip is mainly to the north-east. The strata are inclined at an angle of about 30° more or less, at different points. Within the British territories, they commence at Roopur on the Sutlej in inconsiderable heights. Stretching on towards the south they include the valley of Pinjore, and are here of but low elevation, and continue on to the Jumna but a few hundred feet in height. On the eastern bank of the Jumna they attain a greater height, till about half way on to the Ganges, where in the Kheeri pass they rise to an elevation of 2,000 ft. above the plains, or 3,000 above the sea. They fall off towards the Ganges, where their height is perhaps about 1,000 feet above the plains. On the east bank of the Ganges they are of nearly the same height, and run down a long way to the southward, skirting the flank of the Himalayahs.[1]

Between the Jumna and Ganges, the Sewalik hills are about 8 miles in breadth across their direction. They are intersected by numerous gorges or passes, connecting the plains with the Dhoon valley. The gorges where the Jumna and Ganges emerge into the plains are broad. The other passes which form the beds of torrents during the rains are wide at their mouths towards the plains, and gradually contract towards the Dhoon.

Approaching from the plains, the Sewalik hills are seen to rise with an abrupt, irregular, and deeply indented front. There are no round-backed hills. The crests are sharp ridges descending on the one side in a steep precipitous cliff, and on the other in a smooth and highly inclined slope. Ridge succeeds ridge in this manner, so as to form, across the line of direction, a series of close-packed serrated peaks, or a succession of pretty regular salient and re-entrant angles. So marked is this feature that in the approach one imagines he

[1] Captain Herbert, vol. xvi. Asiatic Researches.

is coming upon rocks of an older date and more durable structure. The strata may be divided into two classes: 1st, and lowermost, sandstone and conglomerate, containing subordinate beds of clay; 2nd, and uppermost, gravel.

The sandstone is a whitish grey arenaceous rock, varying a good deal in characters. It is generally of a whitish grey fine quartz basis, containing scales of white and some dark mica. It is incoherent and crumbles easily from pressure of the fingers. In some places the texture is so loose that it looks, where the surface of a cliff has been acted on by the weather, like well-packed sand. In others, although still loose in texture, it resists a sturdy blow from the hammer. The cementing basis is carbonate of lime, which is upon the whole abundant in the rocks. In the friable descriptions it is less so; the harder varieties effervesce strongly with acids. In some places the sandstone is extensively coloured by decomposed iron pyrites,[1] and this especially occurs where it contains lignite, as in the Kalowala pass. Where it comes in contact with the beds of clay, or the strata of conglomerate, the cementing basis is largely composed of argillaceous matter; and the rock possesses great hardness and tenacity. The sandstone, as above described, forms by far the greatest portion of the rocky mass of the lower hill strata. In some places fine sections are exhibited of great extent. About the middle of the Kheeri pass, a perpendicular cliff rises from the bed of the pass to a height of nearly 2,000 ft. It is of course inaccessible, except at the bottom; but so far as the eye can detect, it consists nearly uniformly of deep strata of whitish grey sandstone, without conglomerate or beds of clay.

The conglomerate consists of a clayey and arenaceous basis, in most instances highly impregnated with carbonate of lime, and cementing waterworn fragments of the older rocks of the Himalayahs. Captain Herbert has enumerated quartz, greywacke, granite, hornblende, and limestone: the fragments are usually of no great size. The strata vary in depth from a few inches to many feet, and alternate with the strata of sandstone. They are conformable, and regularly inclined with the sandstone strata.

The beds of clay are found in the sandstone and conglomerate, and modify the character of the rocks where they occur. The clay possesses different characters. In some places it is blue and tenacious, mixed up with sand; in others, yellow or light flesh-coloured, and greasy to the feel. It is generally lumpy and unequal, and rarely shows any appearance of foliation. The beds are of unequal depth, and rarely of any

[1] Cautley, *loc. cit.*

great extent. The depth, from a few inches to a foot and a half, thinning off and disappearing within a line of a few yards. It is very often accompanied by thin seams of coal or lignite, varying from a few lines to four inches—rarely more. The beds are very unequally distributed in the different portions of the range. In the Kheeri pass, clay is nearly absent, or seen only in very small quantities. In the Kalowala and Timli passes it is seen in more abundance. It is described as showing itself in a thick bed at Silani, by Lieut. Cautley.[1]

The sandstone and conglomerate occupy about three-fourths of the sections across the range, as exhibited in the different passes.

Lying uppermost, and in strata in every respect conformable with the sandstone, we meet with the deposits of gravel. The hills of which it is formed exhibit the same appearance as the other parts of the range. The same precipitous cliffs are seen towards the plains, and the same slope towards the Dhoon; but the strata never attain the height to which the sandstone reaches. Where the gravel is in contact with the uppermost bed of sandstone there is a gradual transition from the one rock to the other, or no very marked contrast in texture between them. The gravel here contains a great abundance of sand, the pebbles are small, seldom above an inch or two in size. The texture of the rock is very loose, and it crumbles under the fingers—lines of stratification are distinctly marked. Progressively as we get on towards the upper beds, the size of the pebbles increases, and the quantity of sand decreases, till in the uppermost beds, which are still clearly stratified, and inclined at the same angle as the rest of the range—about 30° to 35°, the gravel consists chiefly of large water-worn boulders, about half a foot or more in diameter. The deposit here has exactly the characters of the rolled boulders and gravel which form the bottom of the pass, which is itself in the rains the bed of a rapid stream, entirely dried up during the hot weather. The extent of the gravel is about two miles, and the cliffs in some places attain a height of 800 to 1,000 ft. above the beds of the passes.

Besides the beds of clay, the sandstone and conglomerate contain tabular masses of sandstone of a more compact texture, with the plain of gravitation parallel with that of stratification. The lower beds of gravel contain similar masses, but appearing to belong to the sandstone of the range. Nodules of clay are contained in the sandstone and conglo-

[1] Described as foliated or shaly at Silani. Cautley, *loc. cit.*

merate, and in some places the surface of exposed conglomerate is seen to be patched over with portions of a thin very crystalline carbonate of lime, simulating very much the appearance of portions of compressed marine bivalve shells, which I at first suspected them to be. They have a round, conchoidal surface, and a suitable thickness; but I have seen no specimen possessing unequivocal characters by which it could be referred to a shell.

Organic Remains.—The existence of coal or lignite in the Sewalik hills has been known since the Goorka war, and has led at different times to the idea that it might be found in sufficient quantities for mining speculation. Cautley and Herbert have described the circumstances under which it is found, and the latter has given a detailed account of its different varieties. The probability of any extensive coal or lignite deposit occurring in the formation will be afterwards considered. The carbonaceous matter is found in the sandstone and conglomerate, or in the beds of clay. I have specimens of it passing through every variety from a brown lignite, with the scarcely altered characters of a dicotyledonous wood, to a scarcely bituminised coal, of rich black with a high lustre and with no trace of woody structure. In its most perfect state it is but slightly bituminised, and it has more the characters of jet than of coal. It is found deposited in two ways; first, in thin wavy laminæ, from a few lines to a few inches deep, along the flexuous surface of the thin beds of clay. It is likely that here it was formed of vegetable matter left in small patches of limited lacustrine basins, such as the small *jhils* of Hindostan, or in the bed of a small sluggish stream. Secondly, in solitary masses, traversing the sandstone strata, and forming the ends of a log. It is often in such situations accompanied with a discoloration of the sandstone about it, owing to impregnation with iron from decomposed iron pyrites. It here has been formed of the imbedded trunk of a tree deposited in the sandstone. When of this description, it often retains a highly ligneous character. Of a number of specimens which I have examined from different localities, the lignite has always been of a dicotyledonous wood. I have seen no trace of any monocotyledonous woody remains. I have not been able to refer the woods to any class among the dicotyledones. No specimen has shown any of the characters of the wood of the Coniferæ, although the fibres were examined under a powerful microscope. One very perfect specimen in my possession, consisting of a large portion of the transverse diameter of the trunk of a large tree, has the bark converted into a substance nearly as hard and lustrous as jet; the woody

fibres are carbonised, and the interstices between them impregnated partly with siliceous matter, and partly with hydrated (carbonate of?) iron. No other vegetable remain has been seen, and so far as I know no portion of a leaf or other vegetable structure of any kind. In the Timli pass, I came upon a fine section of sandstone, in which from eight to ten feet are exposed longitudinally of the trunk of a large dicotyledonous tree, one foot nine inches in diameter, and upwards of five feet in circumference. The wood is silicified, part of the bark converted into lignite, and impregnated with crystals of sulphate of lime.

From the above description it will be seen that the Sewalik hills consist of a succession of beds, irregularly distributed, of sandstone, shingle, and conglomerate, surmounted by gravel. The section will give a general idea of the arrangement of the rocks; but it by no means professes to be exact in the details (see fig. 1).

Very opposite opinions have been advanced regarding the age of the Sewalik hill formation. Captain Herbert, from the occurrence of lignite and from the stretch of the range on to the Sutlej, was led to think that it was connected with the saliferous beds of Lahore, and might be identical with the new red sandstone of England. Captain Cautley advanced a similar opinion, more with the laudable object of having the matter agitated than determining it himself; but he has long since dropped it. Dr Govan designated the formation as belonging to the older alluvial deposits of Buckland. One can scarcely imagine more opposite geological conceptions of a formation. Mons. Jacquemont examined the lower hills in 1831, but I am not aware of any opinion he may have formed regarding them.

[The manuscript here ends abruptly, but the following passage is extracted from the Essay on Tea Cultivation above referred to, page 11.—Ed.]

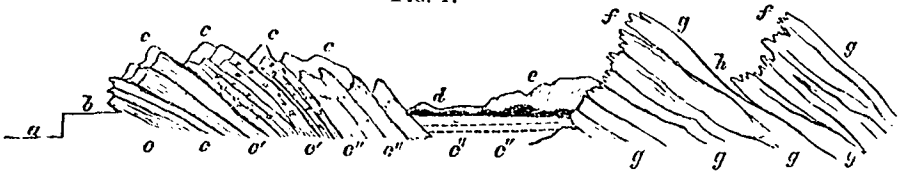
'I regard these hills as an upheaved portion of the plains at the foot of the Himalayahs, and that they are formed of the débris of the mountains washed down by streams and other natural causes. They are covered with vast forests of saul, toon, and fir, and are uninhabited.

'The soil of the Sewalik hills and of the valley of Deyra takes the character of the rocks. It is dry, sandy, or gravelly, with a considerable quantity of calcareous matter, and it appears to me to possess the character indicated for the tea districts in China.

'The Himalayahs have a direction running from NW. to SE. They consist, on this side of the snowy range, chiefly of primary rocks inclined at a considerable angle. The dip of

the strata is to the E. of N. and their abutment to the W. of S. On the flank of the great range there is a line of low hills, the Sewalik, which commences at Roopur on the Sutlej, and run down a long way to the south, skirting the great chain. In some places they run up to and rise upon the Himalayahs; in others, as in this neighbourhood (Suharunpoor), they are separated by an intermediate valley. Between the Jumna and Ganges they attain their greatest height, which Captain Herbert estimates at 2,000 feet above the plains at their foot; or 3,000 above the sea. Suharunpoor is about

FIG. 1.



a, Level of the sea at Calcutta; *b*, Level of Suharunpoor, 1,000 feet above the sea; *cc*, The Sewalik hills; *c'c'*, The strata of sandstone and conglomerate; *c''c''*, Strata of gravel; *dd*, The valley of Deyra; *ee*, Strata of the Sewalik hills, in some places rising on the Himalayahs; *ff*, Outer ridges of the Himalayahs; *gg*, Primary strata; *h*, The valleys or hollows between the ridges.

1,000 feet above the sea. About twenty-five miles north are the Sewalik hills. They are here about six or seven miles wide. To the east of the Ganges and west of the Jumna they gradually fall off. They have the same direction with the great chain, and agree generally in dip; their slope being towards the north, and abutment to the south. They rise at once against the plains, with an abrupt mural front. They are serrated across their direction, forming a succession of scarcely parallel ridges, with a steep face on one side, and slope on the other. The strata are inclined at an angle of 25° to 30°. They are of recent tertiary or alluvial formation, and consist of friable sandstone or gravelly conglomerate, agglutinated by a calcareous cement, containing subordinate beds of clay; the upper strata are entirely gravel. Beyond these hills lies the valley of Deyra, 1,200 or 1,400 feet above the sea, and then the great chain of the Himalayahs. The foregoing rude sketch will perhaps give an idea of the whole better than description; the distances are not in proportion in the section.'

C.

THE SEWALIK FAUNA—ITS EXTENT AND PECULIARITIES.[1]

The fossils were either collected at the foot of the cliffs, or blasted out of rock, or excavated. They were of two sorts, those formed in the sandstone being hard, while those in the

[1] This section is mainly constructed from letters written by Dr. Falconer.—[ED.]

clay were soft. The fossil Proboscidea are the most striking among the remains. The ordinary *Proboscidea* (*Dinotherium* being regarded as an aberrant form of the same family) may for convenience be divided into two genera, *Mastodon* and *Elephas*; although the Sewalik fossils show that these so-called genera are indistinguishable through any characters derived from the form and structure of the teeth. There is, indeed, a gradual and continuous passage in the structure of the teeth between the mastodon and elephant, the forms which have been included under the name of *Mastodon Elephantoïdes* by Clift and one of the Sewalik species constituting the intermediate links. These links are so complete in regard to the development of enamel, ivory, and cement, and the number and form of the dental ridges in the molars, as to break down the technical distinctions founded upon the structure of the teeth which it has been attempted to make between mastodon and elephant. The species of mastodon may be ranged under two sections, viz.:—

I. *Trilophodon*, or the mastodon having a ternary formula in the ridges of the intermediate molar teeth.

II. *Tetralophodon*, including the species with a quaternary formula.

Of *Trilophodon* there are no Indian species yet discovered, the group being at present limited to Europe and America, such as *M. giganteus*, *M. angustidens*, and *M. Tapiroides*. Of *Tetralophodon* there are three Indian species, viz. *M. Sivalensis*, *M. Perimensis*, and *M. latidens* (of Clift *ex parte*).

Elephas we divide into three sectional groups, viz.:—

I. *Stegodon*, being the species which Owen calls *Transitional mastodons*—the *M. Elephantoïdes* of Clift, and of which there are three, and perhaps four, Indian fossil species, viz. *Elephas Cliftii*, *E. insignis*, *E. bombifrons*, and *E. Ganesa*.

II. *Loxodon*, the species allied to the African elephant, of which we have but one Indian fossil species, viz. *E. planifrons*.

III. *Elasmodon*,[1] or the *thin-plated* Elephants (quoad molars), being the species allied to the mammoth and existing Indian elephant, of which two fossil species are found in India, viz. *E. Hysudricus*, a huge species with a concave forehead, and *E. Namadicus*, the species from the Nerbudda valley, with the remarkable bulge around the forehead. In all, ten fossil species of mastodon and elephant, as well as a new fossil species of *Dinotherium*, have been found in India. Six of these species have been found in the Sewalik hills. *Mastodon Perimensis* and *Dinotherium Indicum* come from

[1] Afterwards called *Euclephas* (See description of plates in Fauna Ant. Siv. Plates 42 to 44).—[ED.]

Perim Island, *Mastodon latidens* and *Elephas Cliftii* from Ava, and *Elephas Namadicus* from the valley of the Nerbudda.[1] It follows, that in the Sewalik hills alone there were nearly as many fossil species of mastodon and elephant as there are now species of the whole order of *Pachydermata* upon the continent of India.[2]

Next come the *Hippopotami*, of which five fossil species have been found in India. One of these, *H. Palæindicus*, is a true hippopotamus with four incisors allied to the *H. major*, which we have included under the subgenus *Tetraprotodon*. Three, *H. Sivalensis*, *H. Iravaticus*, and *H. Namadicus*, differ from all species hitherto described in having the same number of incisors as the hog, viz. six in both jaws, and consequently we have constituted them into a new subgenus, *Hexaprotodon*. The fifth is so distinct, and in its teeth it so nearly approaches the ruminants as to form a new genus, *Merycopotamus*. The *Tetraprotodon* and *Hexaprotodon Namadicus* are from the valley of the Nerbudda; the *Hex. Iravaticus* from Ava; the *Hex. Sivalensis*, and *Merycopotamus dissimilis* from the Sewalik hills.[3]

Two fossil species of rhinoceros have been discovered in the Sewalik hills, *Rhinoceros Sivalensis* and *R. platyrhinus*; the cranium of the former being remarkably concave on its upper surface, that of the latter being flat. *Rhinoceros Sivalensis* was evidently unicorned, and it was also remarkable in having six instead of four incisors in both jaws. In this respect it resembled the contemporary hippopotamus of the same formations. A third species of fossil rhinoceros comes from Perim Island, *R. Perimensis*; and a fourth from the valley of the Nerbudda, *R. Namadicus*.

[1] For an account of the discovery of fossils in the valley of the Nerbudda, 'in consequence of a hint from Dr. Hugh Falconer,' see Journ. Asiat. Soc. October 1832, vol. i. p. 456.

Extract of letter to Sir Charles Lyell, 1855:—

'I have already made out two *perfectly distinct* Tertiary Faunas in India, the one in the Nerbudda (i.e. Central India), comparatively late, and characterised by *Elephas Namadicus*, *Hippopotamus palæindicus*, and a large species of *Bubalus*, with other *Bovidæ*, all of them perfectly different from those found in the Sewalik hills. The elephant is closely allied to the species I have named *Elephas antiquus* of Astiana in Piedmont, the Cromer (in part) and other fresh-water beds of Norfolk, and also of the caves in England and Fouvent in France. Strange it is that *Elephas Namadicus* is nearer to the English species than to the existing Indian species, although in time only a little ahead of the latter. This is a fact for Darwin.

'The hippopotamus of the Nerbudda is like the existing African and Val d'Arno fossil species, a *Tetraprotodon*, while the Sewalik and Ava species are *Hexaprotodons*. We have never yet found *Mastodon* in the Nerbudda Fauna; but we have got sparing remains of one of the Sewalik *Stegodons*, i. e. intermediate elephants, from it.

'The large ruminants of the Sewalik Fauna are none of them of the modern types of *Bovidæ*.'—[Ed.]

[2] The above account is derived from a letter to Mr. Broderip, dated April 6, 1845.—[Ed].

[3] Mainly from a letter to M. de Blainville in 1846.—[Ed.]

The Sewalik fossils include three species of *Suidæ: Sus Hysudricus, Sus giganteus*, and a new genus, *Hippohyus Sivalensis*, with teeth exhibiting a strong tendency towards the hippopotamus;[1] also the *Chalicotherium Sivalense*, one of the most remarkably aberrant pachyderms that have yet been met with, either in the fossil or recent state, closely allied to *Anoplotherium*, but showing a return from the ruminant tendencies of the Cuvierian species back to a more pachyderinatous type, and a closer affinity with rhinoceros.

The family of *Equidae* was represented by three Sewalik species, *Equus Sivalensis, Equus Palæonus*,[2] and *Hippotherium Antelopinum*, the last exhibiting the characters of a small horse, drawn out into the attenuated proportions of an antelope. The remains of a third species has been found in the Netee Pars, and another fossil species, *Equus Namadicus*, has been obtained from the valley of the Nerbudda.

The fossil ruminants of the Sewaliks are surprisingly rich, and include almost every type, fossil or recent, known in the order. In the first place, there are two species of giraffe, *Camelopardalis Sivalensis* and *C. affinis*, and a species of camel, *Camelus Sivalensis*, neither of which genera have before been found in the fossil state. Then there is the new genus, the gigantic *Sivatherium*, bearing four horns, nearly approaching the elephant in size, and considerably exceeding the rhinoceros. Among its chief peculiarities are the immense width of cranium for muscular attachments, the fore and hind horns, the arched form of the nasal bones, as in Tapir; the massiveness, width, and shortness of the face, and the curving upwards of the grinding plane of the teeth, as in Darwin's American ox. As to its affinities, the teeth are those of a giraffe; in its four horns, it resembles the *Antilope quadricornis*, while the near horns resemble those of a dicranocerine antelope from North America. In the head, the nearest affinities are to the ox, in regard to the plane of the frontal and occipital, the parietals being joined on to the occipital. The upper lip was prolonged into a trunk. The front horns were remarkable for their flat form, and in the absence of a bur, notwithstanding the guttering. The neck vertebræ are short, and the legs of huge dimensions. Altogether, the *Sivatherium* was a remarkable form of animal, unlike anything living. Closely

[1] As no description of these fossil *Suidæ* was ever published, the reader is referred to the description of the plates in the Fauna Antiqua Sivalensis (lxix. to lxxi.), and also to a memoir by Messrs. Baker and Durand in the Journal of the Asiatic Society for October, 1836. Vol. v. p. 661; also vol. iv. p. 568.—[Ed.]

[2] M. Lartet, in a letter to Dr. Falconer, dated August 1855, was inclined to regard *Equus Palæonus* as a young individual of either *E. Sivalensis* or *E. Namadicus*.—[Ed.]

allied to it is another new genus, the *Brahmatherium*, from Perim Island. Among the *Cervidæ* are two species of Sewalik *Cervus*, and the *Dorcatherium moschinum*; two other species of fossil cervus, *Cervus Namadicus*, and *Cervus Palæindicus*, have been obtained from the valley of the Nerbudda. The Sewalik fossils also include at least two species of antelope, *Antelope Palæindicus*, and *A. gyricornis*; and numerous species of *Bovidæ*, viz. *Bison Sivalensis*, *Bos occipitalis*, *Amphibos acuticornis*, *Amphibos elatus*, *Amphibos antelopinus*, *Hemibos triquitriceras*; two additional species, *Bos palæindicus*, and *Bos Namadicus*,[1] have been found in the valley of the Nerbudda.

The Sewalik *Carnivora* comprehend fossil species of *Felis*, *Hyæna*, *Canis*, *Fox*, *Mustelidæ*, *Machairodus*, and the new forms of *Hyænarctos* and *Enhydriodon*, or fossil otter.

The *Quadrumana* are represented by four fossil species, and there are also several forms of *Rodentia* and *Insectivora*, including *Hystrix*, *Mus*,[2] and a new undescribed genus, *Typhlodon*.

The Sewalik *Reptilia* are exceedingly rich in forms, particularly of the Crocodiles and Chelonians (*Emys*, [illegible] and *Testudo*), some of which, such as *Leptoch*[illegible] *cus* and *Emys tectum*, are indistinguish[illegible] species; while the *Colossochelys A*[illegible] the order. It is in every part[illegible] land tortoise, estimated from [illegible] a shell twelve feet long and [illegible] connection of this fossil wit[illegible] minently in the Pythagor[illegible] subject of interesting sp[illegible]

Among the Sewalik [illegible] several species of *Bird*[illegible] in size the gigantic e[illegible] *Fishes*, *Crustacea*, and [illegible]

* *

At the previous me[illegible] ing you, I had to wa[illegible] explaining, althoug[illegible] which entered int[illegible]

one merely of curious interest, resting on the numerous animals and remarkable forms with which we are occupied. It involves important considerations regarding the former condition of India, in respect of climate, geographical character, and the alterations of surface which it has undergone in the upheavement of the Himalayahs and of the Sewalik hills. To these points I shall now direct your attention; but in order to bring the subject clearly before you, it will be necessary in the first instance to review some of the leading features of the Sewalik fauna.

The first character which strikes us is the wonderful richness and exuberant variety of forms. In the Pachydermata, which are now restricted in continental India to four genera and four or five species, there were then *twice* the number of genera, *and about five times the number of species.* Of the Proboscidean Pachydermata alone, including the elephant and mastodon, there were as many Sewalik species as are now comprised in the whole order in India, and the same holds good as to the Ruminantia. Besides a large number of species representing those which now inhabit the continent, [illegible] the ox, buffalo, bison, deer, antelope, musk-deer, and [illegible]ere more than one species of giraffe and of [illegible]he Sivatherium—in fact, representatives [illegible]e order, fossil or recent, either in [illegible]on through the Carnivora, which [illegible]ed in forms, and through the [illegible]ivora—Birds, Reptiles, Fish, [illegible]is there the slightest proof [illegible]t alive at the same time, [illegible]ferent periods. The re- [illegible]ether, in the same beds

[illegible] analogy between the [illegible]oes, and the extinct [illegible]t a reduced, or as it [illegible]xisted before. India [illegible] the present time no [illegible] detected among the [illegible] to the Edentata.

been found to hold generally good in two other remarkable instances, Australia and America. The former country is at present the head-quarters of the marsupial tribes, and the same is the leading character of what is known of its fossil fauna. In like manner America, which is now the great home of the Edentata, has yielded almost all the gigantic forms of that order known to us—such as the Megatherium and others. But in marking the general analogy which runs between the ancient and the existing fauna of India, we are struck, considering the number of forms which have become extinct, with the extreme reduction of species. Not only have the Proboscidean pachyderms declined from five to one, and the Equidæ from three to one, but numerous genera have died off entirely: we have nothing remaining of the Hexaprotodon Hippopotami, the Merycopotamus, Anoplotherium, Hippohyus, Enhydriodon, Hyænarctos, Sivatherium, Camel, Giraffe, and other forms which I could enumerate. The conclusion is irresistible, that the æra of the great force and development of the vertebrated animals in India has gone by, and that what we now see as our contemporaries are, as it were, but a ragged remnant representation of the rich garment of life with which the continent was f

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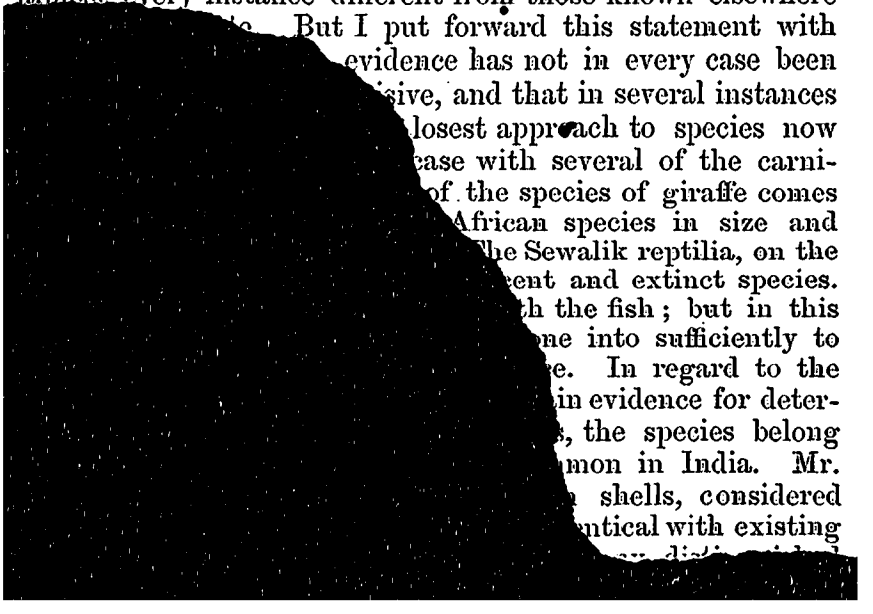
and the hippopotamus as strictly confined to the African continent. But the head-quarters and force of these genera appear to have been formerly in India. In short, it would seem as if all the geographical divisions of the old continent, and all the epochs, from the Eocene downwards, had contributed their representatives to constitute one vast and comprehensive fauna in ancient India.

The next striking point is the peculiarity of type and number of transitionary forms which run as a general feature through the Sewalik fauna. The mastodons and elephants pass into each other through intermediate species. The hippopotami have the full complement of incisive teeth, and the same is indicated in regard to forms allied to rhinoceros. The *Hyænarctos* is the most abnormal in its dentition of any known ursine form. The *Enhydriodon* was a Lutrine animal, the size of a panther: while the *Colossochelys* tortoise was a prodigy of size in its order.

In regard to the nature of the species, in so far as the evidence has yet been worked out among the mammifers, all the ascertained species have turned out to be extinct, and in almost every instance different from those known elsewhere



But I put forward this statement with evidence has not in every case been sive, and that in several instances losest approach to species now ase with several of the carni- of the species of giraffe comes African species in size and he Sewalik reptilia, on the ent and extinct species. h the fish; but in this ne into sufficiently to e. In regard to the in evidence for deter-, the species belong mon in India. Mr. shells, considered ntical with existing

we found the remains of such forms as the camel, giraffe, and quadrumana with existing reptilia pouring in upon us, each successive ascertained form appeared to indicate a nearer and nearer approach to the human period; and when we had exhausted the list, the question used to arise, what shall we find next?—but man and his works were to the last wanting. The Sewalik fauna was not merely surprisingly rich in species, but equally so in the vast number of individuals which the plains of ancient India subsisted. The collection of fossil bones which Captain Cautley presented to the British Museum amounted to 200 chests, averaging about a hundred-weight each of contents. Another collection formed by myself was nearly as extensive. Captains Baker and Durand, in April 1836, at an early stage of their collection, took the trouble of tabulating the number of heads and jaws with teeth contained among their fossils; and the following are extracted from their list.

	Fragments of upper jaws and heads.	Lower jaws.	Mutilated fragments of jaws.
ELEPHANT AND MASTODON.	110	101	56

	Crania and upper jaws.	Lower jaws.
HIPPOPOTAMUS.	46	63

	Upper jaws.	
PACHYDERMATA GENERALLY.	222	225
RUMINANTS.	143	230

Now when it is remembered that the aggregate collections have been more than tenfold increased since, and that the remains were either excavated or found in débris of cliffs, and that the explored surface bears a very small proportion to that which has not yet been investigated, one may form an estimate of the prodigious number of animals which must have lived together in the former plains of India, making every allowance for the bones having accumulated during many successive generations.

Viewed as a whole, what designation are we to assign to the Sewalik fauna? The shell evidence is still to be worked out; but it has already been shown either that the majority are identical with existing forms, or that there is a mixture of recent species with a series of extinct forms closely representing existing ones. The evidence from the vertebrate animals is of a double character; half of them are so like the fauna which we now have in India, that they might pass for the creatures of yesterday, while the other half represents the

characters of the middle and older tertiaries of Europe. That they belong to the vertebrate series which immediately preceded the existing race of animals is hardly susceptible of doubt from the admixture of existing reptiles.[1] * * * And as changes of the fossil fauna of Europe, which mark the different subdivisions of the tertiary series, have been shown to have been coincident with changes of climate, and repeated elevations and depressions of temperature—if we can only show that the climate of India has been less subject to great oscillations during the tertiary period, and that the surface of the land enjoyed longer periods of repose, it would be, perhaps, not unphilosophical to conceive that the epoch of the Sewalik fauna may have lasted through a period corresponding to more than one of the tertiary periods of Europe.

D.

GEOLOGICAL AND CLIMATAL BEARINGS OF THE SEWALIK FAUNA.

Besides the mere zoological interest of the subject, the Sewalik inquiries involve these conclusions.

1. The upheavement of a narrow belt of the plains of India at the foot of the Himalayahs into hills 3,500 ft. high along 11° of longitude, or about 800 miles, after the long establishment on the continent of such modern forms as quadrumana, camel, giraffe, and existing species of reptilia.

2. A great upheavement of the Himalayahs, extending to many thousand feet, and equal to the elevation of a tract which formerly bore a tropical fauna, up to a height which now causes a climate of nearly arctic severity. Remains of rhinoceros, antelope, hyæna, horse, large ruminants, &c., found at 16,000 feet above the sea.[2]

3. Conditions in India during the tertiary period precisely the reverse of what have held in Europe. Instead of a succession of periods with successive decrease of temperature, India has now as high a temperature, if not higher, than it ever had during the tertiary period. The upheavements have operated to increase the heat. In lat. 30°, at 7,000 feet above the sea, the mean temperature, making the compensation for the elevation, and reducing it to the level of the sea, is 81·2° Fahr., or equal to that of the equator. The same excess of temperature holds generally over the continent, as contrasted with the eastern side of the continent of Asia.

4. Instead of numerous subdivisions of the tertiary period with successive faunas, facts tend to the conclusion that India had one long term, and one protracted fauna, which lived

[1] Manuscript defective.—[Ed.]

[2] On this matter, see further the memoir on The Fossil Rhinoceros of Tibet.—[Ed].

through a period corresponding to several terms of the tertiary period in Europe.

The continent of India, at an early period of the tertiary epoch, appears to have been a large island, situated in a bight formed by the Himalayahs and Hindoo Koosh ranges. The valleys of the Ganges and Indus formed a long estuary, into which the drainage of the Himalayahs poured its silt and alluvium. An upheavement took place, which converted these straits into the plains of India, connecting them with the ancient island, and forming the existing continent. The Sewalik fauna then spread over the continent from the Irrawaddi to the mouths of the Indus, two thousand miles; and northwest to the Jhelum, fifteen hundred miles. After a long interval of repose, another great upheavement followed, which threw up a strip of the plains of India, forming the Sewalik hills, and increased the elevation of the Himalayahs by many thousand feet. This event, and the climatal changes which it involved, caused the extinction of the Tibetian and Sewalik faunas. As a result of the climatal changes implicated in these upheavements, it may be inferred that India is now enjoying 'the summer of the great cycle;' and that, in contrast with what has taken place in Europe, there has been no decrease of temperature in that country, which has now as warm a climate, if not warmer, than it ever had during any part of the tertiary period. (See Plate II.)

II. ON THE STRUCTURE OF THE SEWALIK HILLS, AND THE ORGANIC REMAINS FOUND IN THEM.[1]

BY PROBY T. CAUTLEY, ESQ., CAPT. BENGAL ARTILLERY, F.G.S.

(*Read March* 9, 1836.)

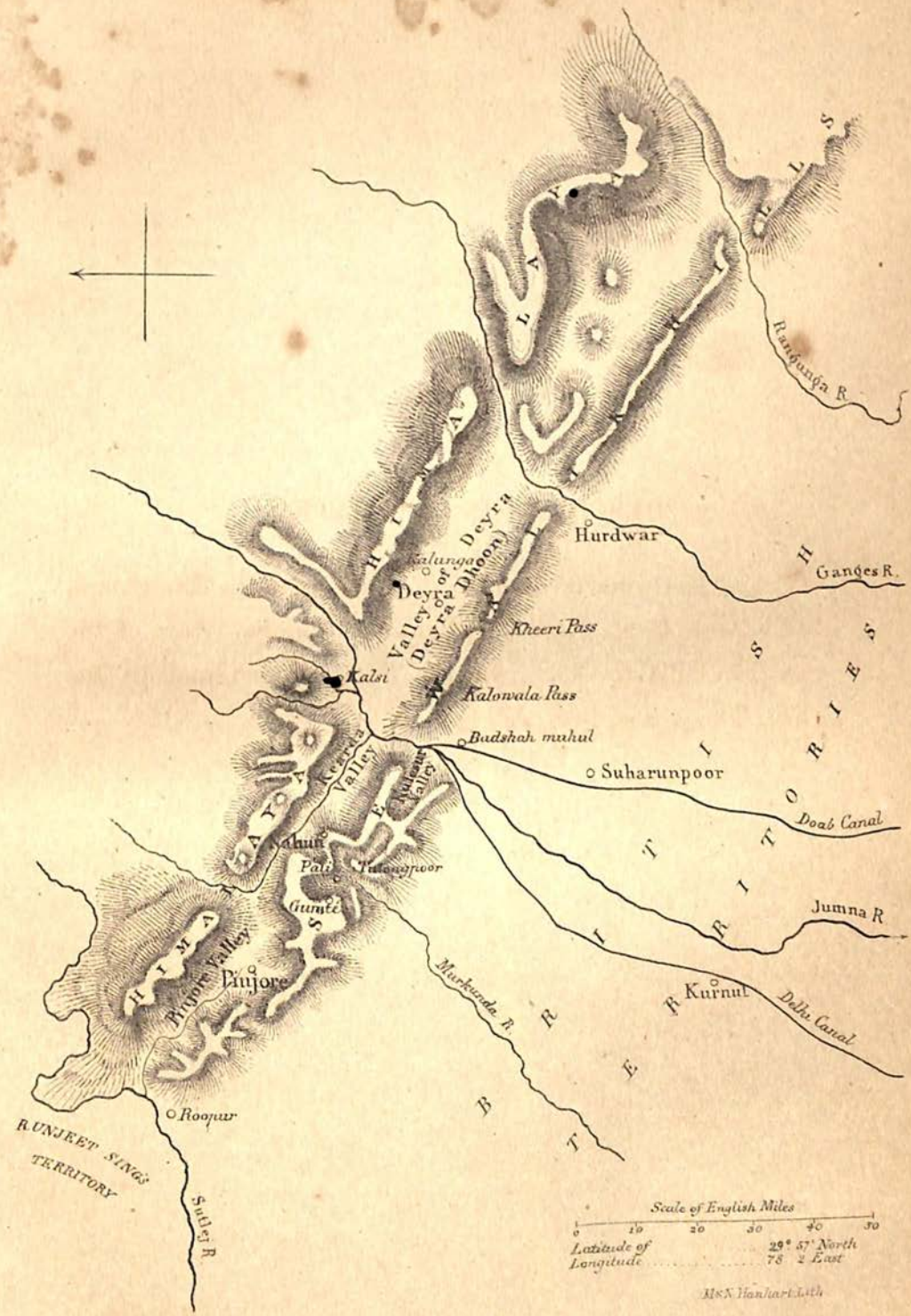
THE mountains, a part of which I am about to describe, range (with the exception of the debouchures of rivers) almost uninterruptedly from the Sutlej, which separates the territory of the British Government from that of the Sikh chieftain, Runjeet Sing, to the Brahmapootra river, and the district of Cooch Behar. Their general bearing, in the portion near the Sutlej, is NW. and SE.; but in that approaching the Brahmapootra it is many points nearer direct east and west. They lie at the foot of the great Himalayan chain, with which they are in some parts connected by a succession of low mountains; but in others, as in the districts under review, they are separated by valleys from three to ten miles in width, and called by the natives Deyra Dhoon, Kearda Dhoon, &c., or the Valley of Deyra, the Valley of Kearda, &c. The highest peaks do not far exceed 3,000 feet, and the generality of the summits vary from 2,000 to 2,500 above the level of the sea. It is necessary, however, to premise, that my observations have not extended further eastward than the Ganges; and that whatever I may record in this paper beyond that river, is given on the authority of others.

Between the Ganges and Jumna rivers, this line of mountains is separated from the great chain of the Himalayahs by the Dhoon, or valley of Deyra, the average width of which may be under ten miles. At the Ganges, or south-eastern extremity, a road passes between the chain and the river; and no difficulty whatever is offered to the approach to the valley. At the opposite or Jumna extremity, on the contrary, the mountains are in many places scarped into the river; and the footpath used by the boat and raft people is an irregular track, over ridge and through hollow, and impinges

[1] This memoir is reprinted from the Geological Transactions, vol. v., Second Series, p. 267.—[ED.]

DESCRIPTION OF PLATE III.

Map of the country between the Sutlej and the Ramgunga, to illustrate Capt. Cautley's Memoir on the Structure of the Sewalik Hills (p. 30). Copied from the original in the Geol. Trans. Sec. Ser., vol. v.



Map of Country between the Sutlej and the Ramgunga.

upon the river at those points only where the stream, in its meandering course, strikes the opposite side of the channel. The intermediate roads, or ghàts, follow the rivers or hill-streams; for in such an utter confusion of mountains any other passage is impossible. A few of these roads are passable for wheeled carriages, but the generality are bad foot-paths. Between the Jumna and the Sutlej are two other valleys, the Kearda and the Pinjore, separated from each other by one of those complex masses of mountains which connect the lower with the upper Himalayah range. The [redacted] generally less precipitous in this neighbourhood; higher points and ridges are separated by valleys, a drainage to the country, and displaying on each and beautiful sections of the stratification. These plateaux—for, with reference to the rivers run them, they may be considered as such—vary in w tend along the whole course of the mountain-streams.

As much confusion may be avoided, in the absence of a native name for the whole range of these mountains between the Sutlej and the Brahmapootra, by establishing one which may be considered legitimate, I wish to propose that of Sewalik,[1] formerly applied to the portion between the Ganges and the Jumna; a name which appears to me better than that of the 'Lower Hills' or the 'Sub-Himalayan,' terms, equally applicable to the subordinate ranges northwards of the Himalayahs.

These preliminary observations, with the appended sketch of the country (Plate III.), will make the reader acquainted with the field of our fossil discoveries; and I proceed to the description of the geological features of the tract. The formations composing the hills consist of beds of boulders or shingle,

[1] In Smith's Exotic Botany, vol. i. p. 9., is the description of the *Rhododendron arboreum*. He refers it 'to the mountainous tract called the Sewalik chain, which separates the planes of Hindostan, between 75° and 85° E. long. from the Himalayah mountains. I make the quotation for the value of the name, though the statement is evidently wrong; the rhododendron in question growing in the Himalayahs themselves at a high elevation, and in company with oaks. The chain separating the plains of Hindostan from the Himalayahs, which is the one now under review, is subject to a mean temperature perfectly inimical to oaks and the *Rhododendron arboreum*. The name is quoted also in Dow's History, and in some traditional writings in the possession of the high priest or Mahant residing at Deyra. The derivation supplied by the high priest is as follows:—

'Sewalik, a corruption of *Shibwalla*, a name given to the tract of mountains between the Jumna and the Ganges, from having been the residence of Ayshoor Shib, a name of Mahadeo and his son Gun, who, under the form of an elephant, had charge of the westerly portion, from the village of Doodhli, to the Jumna; which portion is also called Gungujur (*gujur*, elephant): the portion eastward from Doodhli, or between that village and Hurdwar, is called Deodhar, from its being the especial residence of Deota, or Ayshoor Shib. The whole tract, however, between the Jumna and the Ganges, is called Shibwalla, or the habitation of Shib.'

either loosely mixed or agglutinated by clay and carbonate of lime; of sands of various degrees of consistency; of marl or clay conglomerate;[1] and of an infinite variety of clays; the two latter being most extensively developed to the westward of the Jumna. The strata dip from 15 to 35 deg., generally towards the north; and the breadth of the inclined beds is from six to eight miles.

The succession of the strata is irregular, with the exception of the shingle in the more northern tracts, where it appears to overlay as well as to alternate with the sandstones; although the débris is in considerable abundance in the courses, and on the flanks of the hills, I have never seen these shingle-beds south of the most northern half [illegible]. A similar remark applies to the marl, but in a less section, as it occurs only to the south. The want of it in the northern sections may be accounted for by supposing it to have been either a local deposition or a general one, which is not exposed throughout its entire range.

Although I consider the whole of this tract of mountain as composed of one formation, it may be of use to divide the portion between the Jumna and Ganges, from that westward of the former river, as it appears to me that there is a marked difference (as before stated) in the shingle strata, as well as in the position and number of the clay beds; although perhaps nothing further than would be exhibited on any extended line of country, formed of débris from different tracts of mountains. The causes which upheaved this district apparently acted more energetically in the contracted surface eastward of the Jumna than in that to the westward; though, in the latter, the surface upheaved is much more extended. I shall therefore divide these notes into two sections; the first consisting of the tract between the Jumna and Ganges, the second, that westward of the Jumna. To commence, therefore, with the range between the two rivers.

HILLS BETWEEN THE JUMNA AND GANGES.

Shingle and Sandstone.—The beds of shingle are of enormous thickness, and alternate with the sandstone. The former precisely resemble the shingle in the beds of the existing great rivers of the country, and consist of boulders of granite, gneiss, mica slate, quartz, hornblende schist, and

[1] I call this stratum clay-conglomerate, the beds being composed of fragments of an indurated clay, cemented together by clay, sand, and carbonate of lime; the clay itself effervescing strongly with acids. The rock is, in general, exceedingly hard and tough, as is shown in those parts where it is in contact with the stream of the rivers, which appear to have had little power upon it.

traps; and every other rock, through which these rivers hold their course. If the beds of the Jumna and Ganges were to be upheaved, in the same way as those of former rivers, the appearance of the strata would be exactly similar. The sandstone consists either of grains of pure quartz, with different proportions of mica, or of an admixture of the other ingredients so common in all river sands. The presence of oxide of iron causes a great variety in colour, from red to gray, whilst the induration of the rock appears to depend on the proportion of carbonate of lime. In the more easterly limit opposite Hurdwar, as well as other places, the stone is quarried for building; and in many localities where it is crystalline it is highly valuable in architecture. On the Jumna are the remains of an ancient hunting palace, built by the emperor Shah Juhan at the end of the seventeenth century; and although now in utter ruin, amongst its fragments are capitals of columns, and scolloped archwork, &c., cut in this sandstone, which prove it to be well adapted for architectural purposes. It is easily worked, and the mixture of mica gives two splitting surfaces. On exposure to weather, however, it exfoliates and crumbles, as is conspicuously shown in some lintels, still in position at Badshahmuhul. The colours of the clays are endless; and a light blue variety, which is found under the marl, as well as higher up in the series, where it contains fresh-water shells, is exceedingly pure. The strata of this blue clay are thin, but those of the other varieties are of all dimensions.

Lignite.—Carbonaceous matter occurs throughout the sandstones, either in detached fragments exhibiting vegetable origin, or in strata or seams composed of sandstones and lignite in equal proportions. Lignite is also found in the marl, but generally in the form of black dust; leaving, on its removal, an indistinct, vegetable impression. In one instance I also met with it in the shingle strata. It has never been found in sufficient abundance to excite an inquiry as to its adaptation for economical purposes; though it is common to the whole of this tract of mountains. Eastward of the Ganges it has been found, to the north of the Moradabad district; and it agrees in every respect with that found elsewhere. It has also been met with at points still more easterly; but the examination of that tract has been very slight. The most interesting point at which I have found lignite is at the mouth of the Kalowala pass, one of the entrances into the Deyra Dhoon, from the plains. A stratum or bed of yellow and red sand, about eighteen inches thick, is there completely charged with lignite, either in long flattened masses, or in transverse sections of trunks of trees,

which show, by their elliptical form, effects of vertical pressure. The lignite, in these cases, constitutes merely the outer covering; the interior of the trunk being composed of the sandstone matrix. The bed is enveloped in strata of the marl, abounding in the remains of animals; and both the lignite bed and the marl appear at this point most distinctly to have been deposited in a hollow; the beds at their lateral extremities gradually attenuating, until they meet the sandstone rock; and the lower surface being concave. Although the marl is evidently limited at this spot, it seems to exist so generally in extended strata, that, supposing it to have formed tracts of marsh land, those tracts must have been very extensive. I have before remarked, that I have seen the marl only on the southern limits of these hills, between the Jumna and Ganges. In crossing the former river, however, the same stratum, with the same organic remains, is met with on the north of the mountain ridge, on which the town of Nahun stands. Here the upheavement has been more violent than elsewhere; and the point of junction of this tract with the higher Himalayahs is consequently much dislocated. It is necessary to state, that there are appearances of trap[1] in the neighbourhood of these disturbances; a fact which may lead hereafter to an interesting geological disquisition on the point of junction. Fossil wood, apparently dicotyledonous, abounds in the sandstone. The woody fibre is generally perfect, but impregnated with the sandstone, and frequently mixed with carbonaceous matter; in which case the fossil is black, and on fracture has the appearance of an intimate mixture of coal and sand, or of an imperfect coal. The only remains of animals yet found are fragments of tortoises.

Marl, with Organic Remains.—As the marl is in greatest abundance in this section, I will now give an account of its organic remains, confining myself to classes and genera. These fossils are in appearance perfect, and the deep black colour which they have derived from hydrate of iron renders them ornamental. The medullary cavities are, in many cases, filled with pyrites, and in others with pure white crystallised carbonate of lime. The greater part of the fossils already procured is from the deposit in the Kalowala Pass; and as my collection is not only large, but abundant in different genera, the number already found in such a limited space indicates the great variety of animal remains which a diligent and extensive search may produce. Teeth, and the more solid part of the bones, are found in the greatest

[1] Dr. Falconer has made the same observation, Journ. Asiatic Soc. Bengal, vol. iv. p. 50; date of communication January 3, 1835.

quantity. Most of the former are perfect, and as sharp in their outline as when the animals existed; and even in the fragments, the sharpness of the fracture proves that they were quietly deposited in the sediment in which they are found. The following is a list of the fossils already discovered in the marl:—

MAMMALIA.

Pachydermata . .	Teeth, and the remains of a species of *Anthracotherium.*
Carnivora	Genera doubtful; but some of the teeth correspond with the third incisor of the bear.
Rodentia	Rat, and a small variety of castor.
Ruminantia . . .	Deer, several varieties, and one molar of a very small species.
Solipeda	Horse, one incisor, and one molar from the right side of the upper jaw: they exhibit a peculiarity in the form of the enamel flexures.

REPTILIA.

Crocodilia	*Gharial.* (*Gavial* of naturalists). Teeth and bones in abundance.
	Crocodile. Teeth, in great abundance, fragments of the osseous plates, vertebræ, and other bones.
Chelonia	*Emys.* Fragments of the plates of the back very perfect; also ribs, with the attached osseous part of the buckler.
	Trionyx. Ditto, ditto. Some marked differences in the form and position of the rugous surface of the fragments of the buckler, may hereafter point out a variety of species.

PISCES.

Vertebræ and Scales—The latter doubtful.

TESTACEA.

Bivalve	Imperfect, but resembling *Unio.*
Univalve	A cast resembling that of the *Paludina* of the present fresh-water.[1]

Besides these more easily determinable remains, there have been found a number of incisor teeth, which I cannot assign to any genus; also quantities of bones, in fragments, and portions of ribs, one of which must have belonged to a large animal; also vertebræ, metatarsal or carpal bones, &c. With the exception of the teeth, the remains are generally in fragments, and separated; nor does it appear probable that we shall meet with anything approaching to a complete skeleton.

[1] The only univalve which has been yet found in the marl is the cast above-mentioned, from the rock north of Nahun. I have entered it here, considering, as I do, that the deposits are identical.

In the tract then between the Jumna and Ganges, the fossil remains as yet discovered are thus disposed :—

Shingle, or Gravel Beds	Lignite, scarce.
Sandstone	Trunks of dicotyledonous trees in great abundance; lignite, and remains of reptiles.
Marl	Remains of mammifers, reptiles, fishes, shells, and lignite.

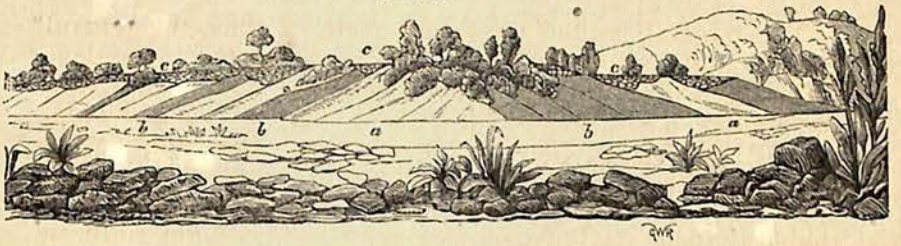
The mineral products are, carbonate of lime, the general cement of the whole formation, also in stalactites and stalagmites; selenite, in small tabular crystals; and pyrites, but apparently in the neighbourhood of organic remains only. Soda abounds throughout the mountains, efflorescing on the shingle and sandstone rocks; and the presence of this alkali may explain the partial disintegration of the boulders of which the shingle is composed: for I believe I am right in asserting, that every variety of boulder, from granite to quartz and sandstones, has been acted on; and when it happens that the boulders can be removed entire from the bed, they fall to pieces, either after exposure to the air for a time, or by pressure of the hand immediately. With regard to fractures in some of the boulders, and their consolidation on different planes, as in a slip of stratification, no remark whatever appears requisite, as these are the necessary consequences of that movement which raised the beds from their horizontal position. There does not appear to be any further remark necessary on this tract, more than can be reserved for the general summary; I shall therefore proceed to describe the hills westward of the Jumna.

HILLS WEST OF THE JUMNA.

These, as I before stated, consist of the same series of shingle, sand, clays, and marls; but they differ, in the beds of shingle being less abundant, although equally inclined, and in containing a different description of boulder. The rolled fragments eastward of the Jumna are all of primary or lower rocks, whilst those to the westward are confined to varieties of clay slate and quartz. The marl, which, between the Jumna and Ganges shows itself in the southern limits, is here exposed at a point north of Nahun, cropping out on the northern slope of the mountain; and the fossil remains resemble those found in the marl eastward of the Jumna, consisting of mammifers, crocodiles, tortoises, fishes, and shells. From Nahun to the plains there is a succession of sandstones and clays, without any abundance of shingle (fig. 2). The sandstone, which, in the vicinity of Nahun, is much indurated, and used for building, becomes softer on approaching

the plains; long before reaching which, the whole formation consists of an interminable succession of sandstones and clays, the latter being in the greatest abundance, of every variety of colour, and dipping, on an average, 20° to the north. The topographical outline of these mountains shows a considerable southing of upheavement, in the hills westward of the

FIG. 2.

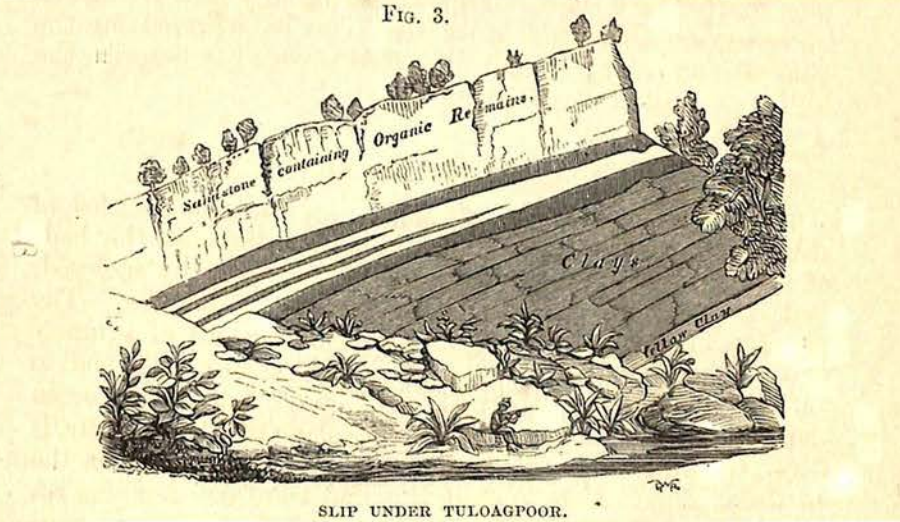


PLATEAU UPON WHICH THE VILLAGE OF DEONI IS SITUATED, ON THE MURKUNDA RIVER.

a. White Sandstone. *b*. Red and Brick-coloured Clay. *c*. Débris.

Jumna, as will be observed in the map;[1] and the circumstance of the fossil remains abounding in the sandstones and clays in this tract, and not in that between the Jumna and the Ganges, may probably be due to the non-upheavement of the line on its prolongation eastward of the Jumna. The drawings which accompany this paper (figs. 2, 3, and 4) show that the action, in all probability, was exerted irregularly;

FIG. 3.



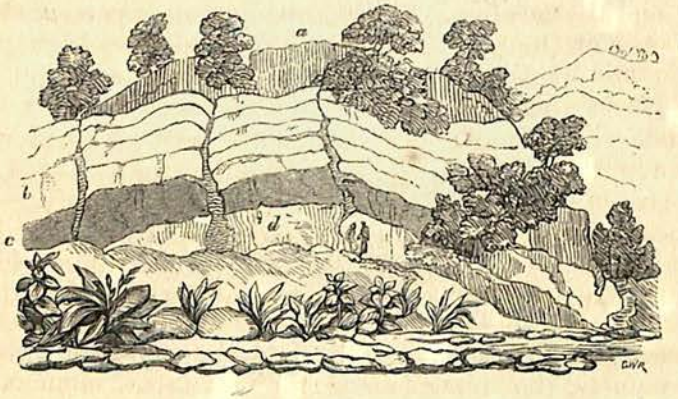
SLIP UNDER TULOAGPOOR.

and although in the large scale we may lay down the dip and direction with accuracy, the former as varying from 15° to 35°, and the latter from NE. to SW., local details give very different results.

[1] Plate III.

The sandstone rock, from which the fossil remains sent to the Society's Museum were extracted, reposes at the above angle, over numberless beds of clays, more or less rich in testaceous remains. The fossil bones lie in great abundance on the surface of the slopes in the neighbourhood of the sandstone, amongst the ruins of fallen cliffs, in the beds of water-courses, &c. The bones which we have had the good fortune to dig out of the rock are perfectly sharp, and in all their original perfection. I may here advert to a circumstance to which the preservation of the water-worn specimens is chiefly due. The sandstone is generally soft, but in the proximity of the fossils it becomes ferruginous, concretionary, and so hard as to turn the edge of the chisel; and thus it protects the fossil from destruction in its progress, as a boulder along the torrent's bed. These concretions are occasionally globular, and become singularly conspicuous, by the weathering of some of the ridges, when the mass of rock takes the appearance of huge spherical concretions piled confusedly on each other.

FIG. 4.



DISLOCATION OF STRATA BELOW THE VILLAGE OF TULOAGPOOR.

a. Clay. *b*. Sandstone. *c*. Clay. *d*. Sandstone.

The organic remains of this sandstone yet brought to light belong to the following classes and genera: most of the species are new; and the appearance of totally undescribed forms will add very considerably to our fossil genera. The new genera themselves will be the subject of separate accounts in their proper place.

MAMMALIA.

Pachydermata . .	Mastodon, elephant, rhinoceros, hippopotamus, hog.
Carnivora . . .	Canine and feline.
Ruminantia . . .	Elk, ox, deer in great varieties.
Solipeda	Horse.

REPTILIA.

Crocodilia	Ghariál, crocodile; both very closely corresponding with the existing species now in the rivers. Lacertine remains indeterminable.
Chelonia	Emys and Trionyx; some of the fragments are of the most gigantic proportions. Of the smaller varieties, nearly entire specimens have been found; upper buckler and carapax complete. My cabinet also contains three heads, wanting only the occipital portion of the cranium.

PISCES.

Genera not established.

Many other fragments have been found, but so imperfect as to render a classification impossible. I may remark, that there appears to be no end to the variety as well as quantity of these remains; and we may expect to do much, even in this remote region, in advancing the inquiries respecting fossil zoology.

Of each genus above mentioned, with the exception of the horse and the carnivora, I have already almost perfect skulls. The bones of the body, however, appear to have been much broken and mutilated; but it is a singular fact, that from many places where the fossils have been found as mere débris of fallen cliffs, fragments of bone have been obtained, which have admitted of being joined, although the fractured ends were coated with carbonate of lime, as if they had been fossilized separately. A beautiful example of this is exhibited in an almost perfect rib of an elephant or mastodon, which is forwarded to the Society's Museum, and which consisted of no less than eight pieces. A perfect humerus of a ruminant has been secured in this state; and the bones of two hind legs, namely, the upper part of the metatarsal connected to the lower portion of the tibia by the intermediate tarsal bones, with, also, the os calcis entire, and all the smaller bones of the tarsus equally so. These remains have belonged to an enormous animal, and, I believe, to the same genus as that of a skull in my possession, and now under description by my friend Dr. Hugh Falconer, of the Bengal medical service, and myself. Although I refrain from zoological details, I must mention that we have an animal evidently forming a connecting link between the *Pachydermata* and *Ruminantia*, or between the *Tapir* or *Palæotherium*, and the latter order of mammalia. The hippopotamus of this sandstone appears to be a new species, having six incisive teeth, besides other peculiarities, particularly in the proportion of the bones of the head: the tusks also differ from

those described by Cuvier in his 'Ossemens Fossiles.' The great depth at which the marl lies beneath the upper strata, with the discovery in it of remains of the horse, is an interesting fact. In the sandstone strata the remains of the horse are by no means scarce. There appears, however, to be a local disposition in the deposits of these remains. In some places the hippopotamus, elephant, mastodon, crocodile, tortoise, &c., are found in abundance, with the remains of ruminants; in others the hippopotamus and the water reptiles are almost totally absent, and only the remains of ruminants and carnivora occur; all tending to prove that these animals were destroyed on the site of their habitats; and that this former world was not more mysterious than the present; that there were vast tracts of marsh and river, with their attendant hippopotami and crocodiles in the waters, and elephants and mastodons in the neighbourhood; and that there were other tracts free from water and marsh, and frequented by their natural inhabitants, ruminants, carnivora, &c.

Dr. Falconer, in a note read at a meeting of the Asiatic Society of Calcutta,[1] suggested the identity of this deposit with that near Prome, some of the fossils from which have been so beautifully lithographed in the Society's 'Transactions.'[2] The mastodons in the Sewalik strata are in great abundance; and as we have perfect skulls, we are enabled to form some opinion of the dentition and the change of teeth. Three of these skulls, now in my cabinet, have the front tooth worn, and the rear one coming into use; the whole line of teeth stretching on a surface of nineteen inches, and forming an arc of 90°. The *front* tooth I cannot distinguish from that of the *M. latidens* figured in the 'Geological Transactions;' and the *rear* one, in the same animal, bears such perfect resemblance to the *M. Elephantoïdes*, that I cannot help risking the conjecture that the *M. latidens* and the *M. Elephantoïdes* are one and the same animal; the specimens, from which the specific characters were taken, having been detached teeth.

Bringing this forward in the way of suggestion may be of use, in ultimately leading to truth. The question, however, must be determined by a strict examination of specimens; and having advanced the above supposition, I will take care that the means shall be provided.[3]

[1] Journal Asiatic Society, vol. iv. p. 58; date of communication, January 3, 1835.

[2] Geological Transactions, 2nd Series, vol. iii. p 377 *et seq.*; pl. 36 to 43.

[3] The rear or newly-formed teeth of every species of mastodon resemble those of the elephant, so far as relates to the integrity of the apices or summits of their transverse ridges; and they might therefore be mistaken for those of the *M. Elephantoïdes*; but the observations which led to the conclusion that the Ava specimens of Mastodon belonged to two

The minerals in this tract, west of the Jumna, correspond with those to the eastward, with the exception of the presence of the gold, which occurs in the beds of the rivers in these mountains, both eastward of the Ganges and westward of the Jumna; but I am not aware of its existence in the intermediate tract. Under Nahun, gold-washers are constantly employed during the dry months; their daily return varying from two annas to two rupees, or from 3*d.* to 4*s.* The process is extremely rude. A piece of board, a long wooden trough, a ladle made out of a gourd, a sieve of the large grass which grows so abundantly in this part of the country, and a piece of hollow bamboo with a little quicksilver, constitute the portable apparatus of these most primitive washers for the precious metal.[1] A great deal of the gold-dust must necessarily be lost by this method of proceeding; and all the mercury, as it is evaporated in open air. The grains of gold are not larger than the small scales of mica, so common in river sand; and I have not heard that the metal has been found in large masses. This gold, too, has its localities, some streams being much richer than others. Where is the fountain head? In some stratum of this alluvium perhaps, yet to be discovered, as the streams have no connection with the higher mountains. A description of the washers, and the method practised by them eastward of the Ganges, have been given in the 'Journal of the Asiatic Society;' and as there is little difference in the apparatus used at both places, it is not necessary to refer to it further.

Some of the fossils obtained by Mr. Colebrooke in the hills near Cooch Behar, and described by Mr. Pentland,[2] are identical with some of those obtained by the present discovery; and as the former were found in the most eastern extremity of this line, it is possible that a careful examination would prove the existence of animal remains throughout the whole of the intermediate mountains; all the tract being probably tertiary. An inquiry into the difference between the hills bounded by the Ganges and Jumna, and those westward of the latter; and into the confused and interminable dislocations, without any flats in the former, and the more scattered ridges with the intermediate plateaux of the latter, would

distinct species were not made on detached teeth. A repeated examination of the jaws and teeth described by Mr. Clift, and the knowledge that his opinion was formed from considering the size and number of the transverse ridges in relation to the length and breadth of the teeth, have tended to confirm my belief in the establishment of two species, which I must retain until further and more definite evidence to the contrary is adduced.—Referee Geol. Soc.

[1] See further particulars of the gold-washings in the Gúmté river, by Captain Cautley, Journal Asiatic Society of Bengal, vol. iv. p. 279; plate 7; April, 1835.

[2] Geological Transactions, 2nd Series, vol. iii. p. 393; plate 45.

only lead to a disquisition on the general formation of the dhoons or valleys lying between the Sewalik hills and the great chain, which the limits of this communication will not admit, and must be left for future inquiry. It will be sufficient to state, that the general form of the mountains approaches more or less to a right angle, the long slope being covered with vegetation, and the crest terminating in a perpendicular and generally mural cliff, which descends into the beds of the torrents. The scenery from these cliffs is most picturesque, and many of the passes or ghàts up the torrents are bounded by gigantic walls of sandstone, varying both in height and character, and subject to all the tortuosities dependent on a river's course, forcing its channel through a complication of mountains. This effect is considerably heightened by the pointed and jagged style of the outline, depending on that abundance of clay and carbonate of lime throughout the whole formation, which permits even the shingle-beds to hold up their pointed summits in the wildest manner imaginable. At places, a perfectly inaccessible needle of shingle raises its head far above the others, and is crowned by one solitary fir tree, *Pinus longifolia*. This conical form, produced in the clays by weathering, is sometimes magnificently displayed, by the whole face of a cliff, consisting of light pink, yellow, and blue clays, being externally decorated with small conical spires of the clay from top to bottom, a height of 1,000 feet from the bed of the river. The origin of this structure is due simply to a little coping stone, of some harder material than the matrix of the strata, and upon which the weather does not act so rapidly as upon the clay. Under a bright sun, the beauty of these cliffs, with their illumined pinnacles, is exquisite; particularly westward of the Jumna. I have before adverted to the presence of great abundance of lime, forming stalactites, and the cement of the sandstone and conglomerate. There is another striking method of deposition on the surface of the large stones which lie in the beds of the rivers, and which, during the greater part of the year, are in contact with the water. The substance is very similar in appearance to the coarse brown paper made in this country: and is produced by the water, while washing the stone, depositing its lime, and entangling the finer particles of vegetable matter, sand and mica, until the stone acquires a superficial coating of a brownish yellow colour, which on removal resembles the substance before mentioned.

MANUKMOW, *near Suharunpoor:*
June 30, 1835.

III. ON THE FOSSIL SPECIES OF ELEPHANT AND MASTODON FOUND IN THE SEWALIK HILLS.[1]

BY H. FALCONER, M.D., F.R.S.

§ 1. General Remarks.

The fossil remains of the Proboscidean Pachydermata have in all ages attracted more attention, both from the learned and from the unlearned, than perhaps those of any other family of extinct animals. Until a comparatively late period in Europe, and at the present time in all countries where the light of anatomy cannot be brought to bear in solving the mystery of their indications, the enormous bones of this tribe, when disinterred from the earth, have been regarded as demonstrative evidence of the former existence of Titans, Giants, and other fabulous beings handed down to us in the records of superstition and mythology. Like the Greeks and Romans of old, the people of India even now usually refer such remains to the *Rakshas* or Titans, who hold so prominent a place in the ancient writings of that country. The severe investigations of modern science have expelled these fictions

[1] This memoir comprises the only portion of the letterpress of the Fauna Antiqua Sivalensis which ever appeared (in 1846). A continuation of the letterpress found in manuscript among Dr. Falconer's papers is now added to the part already published. The work was prefaced by the following remarks:—'The plan which we have laid down for our guidance in the conduct of this work is, in the first place, to determine the remains of the extinct genera and species, and, on the conclusion of the systematic and descriptive details, to investigate the general results to which they lead. The advantages of this method are so obvious that it is unnecessary to insist upon them; for general conclusions in science are of little value, if the facts upon which they are founded be not in the first instance rigidly and accurately ascertained. The order to be observed in describing the different families will depend more on the state of preparation and convenience of the materials than upon any strict principle of zoological arrangement. This, which might be deemed objectionable in a general systematic work, is of little consequence in the case of a particular Fossil Fauna, provided that the forms in each family and genus are taken in sequence. The great palæontological work of Cuvier opens with the Pachydermata, the proboscidea being the first in the order of description. Following our illustrious guide in extinct zoology, we shall commence with the Elephant group, in which is most signally displayed the numerical richness of forms which characterizes the Fossil Fauna of India.'—[Ed.]

from the belief of civilized mankind, and reconstructed the true forms of the animals which appear, in many instances, to have given rise to them. Palæontology made, as it were, its first great advance in the exact determination by Cuvier of the mammoth of Siberia, and the mastodon of North America. Since that time several new forms have been discovered, and most of the great points connected with the structure of the Proboscidea, fossil and recent, have been ascertained. But, notwithstanding the vast amount of observation on the subject during late years, a great difference of opinion has prevailed among comparative anatomists and palæontologists, down even to the period when we now write, in regard to the degree of affinity and generic relation of the different species of mastodon and elephant. The majority of late authorities, including Cuvier and Owen, have regarded them as constituting two distinct and well marked, although closely allied, genera; others have gone the length of breaking up mastodon into two genera; while M. de Blainville has reverted to the opinion of some of the earlier observers, that the so-called mastodons and elephants are but modifications of one common type, differing so little from each other that all the species may, with propriety, be included within the limits of a single genus. A still greater and vastly more important difference of opinion has prevailed regarding the number and characters of the species; for, while the conflicting views respecting the generic distinctions concern little more than the principles of systematic classification, the accurate determination of the fossil species affects the value of facts, which implicate the accuracy of some of the most weighty arguments in the geology of the later tertiary strata, more especially such as relate to the changes of climate which are supposed to have accompanied their deposition, and the extension of the species through a wide range of time and space. Cuvier considered all the elephant remains which have been found in Europe, the north of Asia, and America, whether occurring in the superficial drift of Siberia, or in the tertiary beds of the Val d'Arno, to belong strictly to a single species, *Elephas primigenius*. Professor Owen, with all the lights, and wielding every arm of an advanced science, holds the same opinion. M. de Blainville does not think that there are sufficient characters even for separating the mammoth from the existing Indian elephant, both of which he appears to regard as varieties of the same species.[1] On the other hand, Nesti, after a careful study of the elephant remains of Italy, during a period of nearly twenty years, upon

[1] De Blainville, Ostéographie; Elephants, p. 222.

an ample collection of the best materials in the form of crania, jaws, and teeth, insists upon the specific distinctness of the Tuscan fossil elephant, *E. meridionalis*, from the true mammoth of Siberia. Other palæontologists have gone so far as to construct ten species out of the single species of Cuvier, founding the distinctive characters upon the differences presented by the molar teeth. A like range of conflicting opinions has prevailed in regard to the mastodons. Cuvier, Owen, and De Blainville concur in restricting the narrow-toothed mastodons of Europe to a single species, the geographical range of which Cuvier extended even to South America; while Croizet and Jobert, Kaup, Von Meyer, and others, divide them into two, *M. longirostris*, and *M. angustidens*. No less than two genera and at least ten nominal species have been founded upon teeth, which Owen, De Blainville, and most other authorities, attribute merely to different ages and sexes of a single species, the *M. Ohioticus* of North America. In short, the ascertained fossil species, exclusive of those of India, according to some, are limited to one elephant and four or five mastodons; while others would raise the number of the former to ten, and of the latter to upwards of twenty.

This great diversity of opinion, almost unequalled in regard to any other section of mammalian palæontology, has in a great measure arisen from the isolated and often defective nature of the materials relating to this tribe, as they ordinarily come before the palæontologist. From the peculiar mode of succession of the molar teeth, which yield the principal distinctive characters in mastodon and elephant, by repeated renewals from back to front, at different stages of the animal's growth, as the worn and exhausted grinders drop out, a limited number only of the whole series can be met with in any one fossil specimen, even under the most favourable conditions. It is this peculiarity which has so long retarded the attainment of an accurate knowledge of the dentition of the living species. The difficulty applies with double weight to the fossil species,[1] for the teeth are rarely met with in connection with perfect crania and jaws; they most frequently occur detached, or connected with mutilated fragments. It is only, therefore, from the com-

[1] In illustration, it may be mentioned that Eichwald (Nova Act. Acad. Nat. Curios. 1834, vol. xvii. p. 735, tab. liii. fig. 2), in a memoir descriptive of fossil remains of Elephas, Mastodon, and Dinotherium, &c., found in Poland, figures and describes what appears to be a fragment of the symphysis of the *lower jaw* of *Dinotherium* as a portion of the *upper jaw* of a new species of mastodon, which he names *Mastodon Podolicus*. Other equally remarkable cases of the same kind might be adduced; so unsafe is it to draw conclusions regarding the fossil Proboscidea from imperfect materials.

parison of an extensive series of specimens, embracing every period of life and the range of individual and sexual varieties through which the species runs, that any safe conclusions can be drawn regarding the distinctive characters of any one form. In consequence, although palæontologists are agreed on the great points relating to the construction of the head, trunk, and extremities, hardly any two concur respecting the number, form, and succession of the teeth in the different species of mastodon and elephant.

The surprising number of forms belonging to this family, embraced in the fossil fauna of India, and the immense abundance in which their remains have been met with, have placed us perhaps, with respect to the quantity and perfect condition of the materials, in more favourable circumstances for the determination of the Sewalik species than has ordinarily happened to the palæontologist in the case of most of the other fossil Proboscidea. Of five of the species to be described in the sequel, we possess nearly perfect crania of each, and, in most of the instances, crania with teeth of all ages, from the very young up to the adult animal, in addition to a vast collection of the detached teeth and lower jaws, so as to furnish us with the whole of the essential evidence requisite for the specific determination of each of these forms. The distinctive characters are so broadly marked, that there is hardly room for a doubt being entertained in regard to them. In the course of the investigation, we have been led to examine the conclusions which have been arrived at by writers who have preceded us upon this family. The Indian species, and those previously described, fossil and recent, have mutually reflected light on each other, and ranged themselves into natural and allied groups. Instead, therefore, of restricting ourselves merely to a description of the Sewalik fossil forms, we shall endeavour, in what follows, to trace the affinities, and institute an arrangement of all the well-determined species in the family.

The results to which we have been conducted lead us to differ on certain points from the opinions most commonly entertained at the present day; for while, on the one hand, it would appear that the fossil species of both elephant and mastodon have been unnecessarily multiplied by authors both in Europe and America, on the other, we are compelled to think that Cuvier and others have run into the opposite extreme of caution, and in more than one instance included distinct forms under the same nominal species. Further, in regard to the views which have been at different times advanced respecting the differential characters of elephant and mastodon, in the succession and development of the

series of molar teeth, our conclusions are, in some measure, at variance with those of most other palæontologists who have preceded us upon this family.

Before entering upon the description of the species, we shall examine, at some length, the general characters presented by the teeth; but in order to comprehend the present state of knowledge on this branch of the subject, it will in the first instance be necessary to pass briefly under review the leading opinions which have been entertained by palæontologists regarding the relations of mastodon and elephant to each other, and to notice the successive steps in the discovery of new forms which have led to the modifications of these opinions.

It is beside our object to give anything like an historical account of the labours of the earlier writers. Those who are desirous of the information will find it detailed in the great work of Cuvier, down to the period at which he wrote; and for subsequent opinions, they may consult the 'Ostéographie' of De Blainville, now in course of publication, and the writings of Professor Owen, Bronn, Von Meyer, Kaup, and other palæontological authors.

Notwithstanding the earlier contributions of Daubenton, Pallas, Merck, and the elder Camper, hardly anything was known regarding the succession of the teeth in the elephant, except that they are repeated oftener than once during life, by protrusion in the jaws from behind forward, till the appearance of the memoir by Corse,[1] in the 'Philosophical Transactions' of 1799. This excellent and careful observer had resided many years in India, in charge of a Government stud of elephants in Bengal. By captures of herds of the wild animal he had an opportunity of watching the successive fall and renewal of the teeth from the youngest age up to the adult, the periods of which he carefully recorded; and casualties supplied him with a series of upwards of thirty crania of all ages, upon which he studied the form, size, and the number of plates which enter into the composition of the grinders at different stages of the animal's life. The observations embodied in this memoir are the most valuable which have been made on the teeth of either of the living species. Corse first showed that the Indian elephant has 'milk' tusks (incisors), which cut the gum when the calf is about six months old, but are extremely caducous, as they drop out between the first and second year. He detected the position of the capsule of the permanent tusks, which protrude about two months after the milk incisors are shed, and go on in-

[1] Corse, Phil. Trans. 1799, vol. lxxxix. p. 205.

creasing in size during the rest of the elephant's life. He has described the variations in size, form, and direction which the tusks present in the different sexes and castes of the Indian species, the general character of which castes he has accurately recorded; but the most valuable part of his observations is comprised in what relates to the molar teeth. He showed that they are reproduced several times during life, and that the number of plates entering into the composition of each molar goes on increasing as the teeth are successively renewed. This succession he has carefully traced up to the fourth grinder: the first cuts the gum eight or ten days after birth, is well out at six weeks, and is composed of four plates; the second is completely in use at two years, and consists of eight or nine plates; the third serves the period between the second and sixth year, and has twelve or thirteen plates; the fourth is in use between the sixth and tenth year, and consists, according to Corse, of about fifteen plates. Puzzled, probably by the irregularity in the number of plates, and the size of the rest of the molars in different individuals, this faithful observer stops short at the point where his observations ceased to be conclusive, and does not attempt to define the number of plates in those which follow after the fourth. He states, generally, that the plates go on increasing successively up to the 'seventh or eighth set,' when each grinder consists of twenty-two or twenty-three plates, being the greatest number which he had observed.[1] These observations were of especial value in furnishing a standard of comparison for the teeth of the fossil species; and by establishing the existence of milk incisors, they proved that part at least of the dental system of the elephant agreed with that of the ordinary Pachydermata. But Corse was at fault in the conjecture that eight molar teeth are successively developed in an antero-posterior series in this animal; for if this were the case, the elephant would form an exception to a general law in the Pachydermata and allied orders, among which the normal number of milk molars does not exceed four, that of the true molars being invariably three.

Notwithstanding this objection, Corse's numerical statement was adopted by Cuvier and by all other authors prior to 1844, when it was, for the first time, challenged by M. de Blainville in the part of his 'Ostéographie' devoted to the elephants. Bronn,[2] in his 'Lethæa,' gives eight molars on each side of both jaws to the genus Elephas; and Dr. Grant,[3] in his memoir upon the Proboscidea, puts forward different

[1] Corse, *loc. cit.* p. 224.

[2] Bronn, Lethæa Geognostica, 1838, p. 1240.

[3] Grant, Geolog. Proceedings, 1842, vol. iii. p. 771.

dental formulæ in the molars as points of generic distinction between elephant and mastodon, attributing eight molars in each side to the former, and only six to the latter.

Cuvier, except in what regards his hypothetical explanation of the formation of the dental tissues, has described with admirable clearness and in great detail the structure and mode of growth of the teeth in the elephant. But he had assuredly arrived at no accurate idea of the true division of the molar series into milk and permanent grinders. He makes no attempt to show where the deciduous series terminates and the true molars begin, although so particular upon this point in his descriptions of the dental system in the ordinary Pachydermata and Ruminantia. In fact, the term 'dent de lait' is but rarely applied in his elephant descriptions; and in these instances it has evidently reference more to the immature age of the animal than in the ordinary sense to a deciduous tooth which is expelled by a vertical successor. Having adopted the excessive numerical formula of Corse, this great anatomist was led to believe that the successional premolars, instead of being suppressed, are developed behind the milk teeth. The language in which this remarkable opinion is expressed is clear and explicit:—'L'on pourroit dire que les dents de remplacement de l'éléphant viennent derrière ses dents de lait, au lieu de venir dessus ou dessous, comme dans les autres animaux.'[1]

The discovery of the entire set of molars in *Mastodon Ohioticus*, by Dr. Hays,[2] in 1834, and in *M. longirostris*, by Dr. Kaup,[3] in 1835, had clearly established that the antero-posterior series in these species does not exceed six, and paved the way for an accurate knowledge of the dentition of the elephant, when M. de Blainville published, in 1844, the osteographical memoir upon this genus contained in his great work. This distinguished anatomist, in his remarks upon the dentition of the Dugongs, first states that the elephants (in which he includes the mastodons) have neither milk teeth nor vertical successional teeth.[4] His words are—'Ainsi l'on peut dire que chez les dugongs et chez les autres lamantins, ainsi que chez les éléphants, il n'y a ni dents de lait ni dents de remplacement, comme chez la plupart des autres mammifères; celles-ci poussant, pour ainsi dire, celles-là de bas en haut, et formant ainsi deux rangées superposées; mais que toutes les dents que doit avoir l'animal dans le cours de sa vie entière forment une seule ligne, un seul rang, une sorte de

[1] Cuvier, Oss. Fossil. tom. i. p. 39, 4to. edit. 1821.

[2] Hays, Amer. Phil. Trans. vol. iv. p. 320, 1834.

[3] Kaup, Oss. Fossil. pt. iv. pp. 65–89, 1835.

[4] De Blainville, Ostéographie, 'Manatus,' p. 75.

boyau cylindrique, qui se développe d'arrière en avant dans le canal dentaire, dont l'énorme diamètre est en partie dû à cette particularité. C'est quelque chose de semblable à ce qui existe dans les éléphants.' This statement is subsequently modified in the portion of the work devoted to the elephants. M. de Blainville there prefers a claim to having first indicated the normal number, the mode of succession, and the true signification of the molar teeth in this genus.[1] He admits, on the evidence of Corse, milk and permanent incisors, but sees no occasion to apply a similar division of 'milk' and 'permanent' to the molar series. He follows their succession from first to last, and vindicates the first part of his claim by showing that in the existing species, and probably in the mammoth, the number of developed grinders is neither more nor less than six. But in regard to their signification, viewed as a series, we cannot, with every respect for this eminent anatomist, admit that he has been equally successful. He divides the six molars into three sets, each consisting of two teeth. The first includes the two anterior molars, which are characterized by being worn out in the part of the jaw where they first protrude; the second set is characterized by being formed in the posterior part of the jaw, and at last pushed out in front; and the third set, formed behind like the two preceding teeth, is characterized chiefly by serving the adult stage of the animal's life, and by the greater space which the teeth have to traverse in progressing forwards. This, however, is at best but an ætal division, and cannot be received as a philosophical interpretation of the theoretical signification of the molar series: for the second of these sets groups together the last milk and the first permanent molar. Further, M. de Blainville expresses, by a numerical formula,[2] his view of the dental system of the elephant, which, if interpreted according to the exposition of his peculiar method of symbols, laid down in the first part of the 'Ostéographie,' would imply that the elephant has three premolars and three back molars, the milk series being suppressed: whereas, in the three species of which the dentition is known, it is in reality the three milk molars that are invariably developed, while the three premolars are constantly suppressed.

[1] *Loc. cit.* p. 58. 'Aussi dans aucun ouvrage le nombre normal, la mode de succession des dents molaires de l'éléphant, et leur signification réelle, n'ont pas été déterminés, ce que nous croyons pouvoir faire aujourd'hui d'une manière positive, en nous aidant, il est vrai, des dents fossiles que possèdent nos collections en plus grand nombre peut-être que des dents récentes.'

[2] *Loc. cit.* p. 75. The formula given is $\frac{1}{0} + \frac{0}{0} + \frac{3}{3} + \frac{1}{1} + \frac{2}{2}$. The signification of these figures, indicated in the opening memoir 'Sur les Mammifères en général,' p. 34, is $\frac{1}{1}$ in. + $\frac{0}{0}$ can. + $\frac{3}{3}$ avant mol. + $\frac{1}{1}$ princip. + $\frac{2}{2}$ arrière mol.

Professor Owen, down to the close of 1844, appears to have held with Cuvier the opinion that the developed molars in the Asiatic elephant amounted to seven or eight. This number, adopted on the authority of Corse, is stated in his 'British Fossil Mammalia.'[1] But it was not likely that the true numerical formula would escape the sagacity of this eminent comparative anatomist when directed to the teeth of the elephant in connection with those of the ordinary Pachydermata. Accordingly, in the last part of his 'Odontography,' while he agrees with M. de Blainville in attributing six molars on each side of the jaws to this genus,[2] he has made a considerable step in advance of the latter anatomist in regard to their signification. The occurrence of a vertical successional premolar in the upper jaw of one or more species of mastodon had previously established that the two anterior grinding teeth in that genus are displaced, like the milk teeth in the ordinary Pachydermata, by a vertical successor. Professor Owen follows up this indication to its legitimate conclusion, and infers that the third molar in the series of antero-posterior succession in the mastodon is the last milk molar, the vertical successional tooth by which it ought, normally, to be pushed out, usually remaining undeveloped. He then extends this view to the dentition of the elephant, and states that 'it is probable that the three preceding teeth' (namely, the three first developed molars) 'are analogous to the true deciduous molars of the ordinary Pachyderms.'[3] The correctness of this opinion is susceptible of demonstration by the dentition of an Indian fossil species which we have named *Elephas planifrons*, to be described in this work. The determination of the point was of great zoological interest, by explaining the apparent anomaly which had hitherto divided the teeth of the elephant from those of the allied families in the order.

Next, in regard to the establishment of the species. The fossil remains of the mammoth had, during ages, attracted more or less attention in every country in Europe, having been found in England and in all parts of the Continent, from Italy to Siberia. But it was only towards the close of the last century that definite notions as to the species were arrived at. Pallas, who had better opportunities for determining the point than any of his contemporaries, upon the perfect remains so commonly met with in Russia, erroneously considered the fossil teeth to be identical with those of the Indian species. A great advance was made in the inquiry

[1] Owen, Brit. Foss. Mammal. part v. p. 225.

[2] *Idem*, Odontography, 1845, p. 626, and note p. 635.

[3] *Idem*, *loc. cit.* p. 634.

through the discovery by Peter Camper of the specific difference between the teeth of the Asiatic and African elephants,[1] when Blumenbach and Cuvier almost simultaneously entered upon the investigation and arrived at the same result, viz. that the mammoth was an extinct form, differing from both of the existing species. Struck with the length of the cranium and of the incisive sheaths in the mammoth, as represented in the figures of Messerschmidt's specimen attached to Breyne's excellent remarks in the 'Philosophical Transactions,'[2] and connecting these peculiarities with the great width of the crown, and the narrowness and number of the plates in the fossil grinders, Cuvier was conducted to his first happy conclusion. The probability of a similar difference characterizing the species in other fossil genera flashed across his mind, and opened to him new views respecting the theory of the earth. Great and important were the results; and after they had been achieved, the illustrious anatomist reverted, in terms of the liveliest acknowledgment, to the long neglected figures of Messerschmidt which had helped him to the first idea.[3]

After determining the specific independence of the mammoth, the next point to ascertain was, whether the remains occurring in very different deposits, and in localities widely contrasted in climate and in geographical position, belonged to the same or to different species. Notwithstanding that the fossil teeth from the southern parts of Europe commonly presented wider and fewer plates, with thicker enamel, than those of the typical form of mammoth found in Siberia, Cuvier attached minor importance to these differences, as the teeth agreed in certain other respects; and he ranged the whole under the single species of *Elephas primigenius*. This opinion has been very generally adopted by subsequent authors—among others, by M. de Blainville and by Professor Owen, who has entered at considerable length upon the question in his 'British Fossil Mammalia,' and decided in favour of the specific unity of the European forms. But notwithstanding this array of authority, we cannot help thinking that Cuvier was premature in his conclusion, and that the identity of the forms has rather been assumed against the evidence than proved by it. Had the differences in the teeth been less considerable than they are known to be, it would have been requisite to show that the crania at least agreed, before this identity could be considered to have been satisfactorily established. But there were not sufficient materials

[1] P. Camper, Descript. Anatom. d'un éléphant mâle, p. 16.

[2] Phil. Trans. vol. xl. 1738, p. 124.

[3] Cuvier, Oss. Fossil. tom. i. p. 178.

for making such a comparison when Cuvier wrote. The cranium of the Siberian mammoth was known to him only through figures of five specimens, not one of which was drawn in any exact projection; and his acquaintance with the Italian fossil elephant, exclusive of teeth, was limited, in regard to the head, to a single mutilated fragment, not extending above the orbits and maxillary bones. There is little doubt, also, that, like other writers, he was partly swayed by the extraneous consideration of the geographic range of the two existing elephants, the continents of Asia and Africa having each but a single species. We have the less hesitation in advancing these doubts, as conclusive proof will be adduced in the sequel that, in the similar instance of the *Mastodon angustidens*, Cuvier and others have included under that name two forms which are so distinct that, in our view, they do not even belong to the same section of the genus; while the Sewalik fossil remains show that there were formerly several species of elephant at one time in the same Fauna in India.

Soon after the publication of Cuvier's Memoir, Nesti, in 1808, proposed an addition to the European fossil species, founded on remains from the Val d'Arno.[1] He put forward two new species: the first, resting on a lower jaw without teeth, was characterized by a peculiar spout-shaped prolongation of the symphysial apophysis; the second, which he named *E. minimus*, also resting upon a lower jaw, was distinguished by its supposed small size, by the absence of the beak apophysis, and by the rhomboid section presented by the plates of the grinders. Cuvier refused to admit either of Nesti's species. The lower jaw of the first he pronounced to belong rather to *Mastodon angustidens* than to an elephant; and the second to be nothing more than the lower jaw of a young individual.[2] Nesti, after a long silence, reverted to the subject in 1825, in a memoir which embodied the results of extensive observations carefully made during seventeen years.[3] He tacitly admits the justness of Cuvier's criticism in regard to the second species, by abandoning *E. minimus*; but in confirmation of his first species he adduces a great mass of evidence derived from numerous crania of all ages, from the fœtus up to the adult, and from lower jaws in the Florence and other Tuscan museums, all of which, he affirms, show the peculiar beak-like elongation of the symphysis in connection with elephants' teeth. The result of the whole was to remove every doubt or hesitation from his mind regarding

[1] Nesti, Annale del Museo di Firenze, tom. i.

[2] Cuvier, Oss. Fossiles, tom. i. p. 186.

[3] Nesti, Nuovo Giornale de Letterat. Pisa, 1825, tom. xi. p. 119.

the distinctness of the Tuscan species, for which he proposes the specific name of *E. meridionalis*.

The value of the evidence regarding this species will be more fully considered in the sequel. Nesti's opinion, however, has met with little favour among palæontologists. Croizet and Jobert have adopted it for some of the elephant remains found in Auvergne,[1] and the name finds a place in the enumeration of species given in von Meyer's 'Palæologica.'[2] But it is not admitted by Bronn,[3] De Blainville,[4] or Pictet;[5] and it would appear from certain passages in the 'British Fossil Mammalia' that the great weight of Professor Owen's authority is against it.[6]

In 1821 Dr. Goldfuss[7] described a fossil grinder found in a collection at Cologne, which resembles very much that of the African elephant, in the characteristic peculiarities of the rhomboid form and reduced number of the grinding plates. He states that the specimen, although the precise locality was unknown, has the cement and ivory as much decomposed as in the fossil grinders from Siberia. In a second memoir[8] he figures and describes other teeth presenting the same characters, from the banks of the Rühr, in Westphalia, and concludes from them that the valley of the Rhine had formerly an elephant, which was more closely allied to the African than the mammoth was to the existing Indian species. He proposed naming it provisionally *Elephas priscus*.

Cuvier threw very strong doubts upon the authenticity of these specimens as veritable fossils, in consequence of the ambiguous circumstances under which they were found. He considered them to be nothing more than disguised remains of African elephants of modern origin.[9] But according to Bronn, fossil teeth of the same description have since been found, under circumstances fully to be depended upon, throughout nearly the whole of Central Europe, from the Rhine to the heart of Russia.[10] Some of them have been described by Wagner;[11] and undoubted fossil teeth, presenting similar characters, have been met with in the 'brick earth' beds of the valley of the Thames, at a considerable depth below the surface. These will be noticed afterwards in connection with the dental series of one of the Indian fossil species.

[1] Croizet et Jobert, Oss. Foss. du Puy-de-Dôme, 1828, p. 123.
[2] Von Meyer, Palæologica, 1832, p. 69.
[3] Bronn, Lethæa Geognostica, 1838, p. 1245.
[4] De Blainville, Ostéographie; Éléphants, p. 220.
[5] Pictet, Palæontologie, 1844, tom. i. p. 243.
[6] Owen, Brit. Foss. Mamm. p. 239.
[7] Goldfuss, Nov. Act. Acad. Leop. Carol. Natur. Curios. vol. x. p. 485.
[8] *Idem, loc. cit.* vol. xi. p. 485.
[9] Cuvier, Oss. Fossiles, tom. ii. (8vo. edit.) p. 184.
[10] Bronn, Lethæa Geog., p. 1244.
[11] Wagner, Karsten's Archiv. xvi. p. 21.

Fischer de Waldheim, in 1829, proposed the separation from the mammoth of no less than five fossil species of elephant, founded upon remains occurring in Russia. These he has severally named—*E. proboletes*, *E. campylotes*, *E. Kamenskii*, *E. Panicus*, and *E. pygmæus*.[1] Dr. Eichwald went still further, and added a sixth species, from Poland, under the name of *E. odontotyrannus*.[2] But the almost universal consent of palæontologists is against these so-called species, which are considered to be nothing more than varieties in the teeth dependent upon age and sex, in individuals of the mammoth.

M. Morren, under the name of *Elephas macrorhynchus*, has lately proposed a new species for some of the fossil remains found in Belgium; but the grounds upon which it rests do not appear to be more valid than in the case of the Russian and Polish species.[3]

Mastodon.—In regard to Mastodon: the first determined species of this genus was the *M. Ohioticus*[4] of North America. The abundant remains found nearly all over the temperate parts of the United States had, as in the instance of the mammoth of Europe, attracted the notice of observant travellers to this great extinct animal, upwards of a century ago. But, till the time of Daubenton, hardly any progress had been made towards a definite idea of its nature. This celebrated naturalist, in 1762, ascertained the close resemblance of the femur and tusks to those of the elephant: but the molars appeared to him to present a nearer approach to the teeth of the hippopotamus, and he was puzzled whether to ascribe the fossils to one or to two distinct animals.[5] Buffon participated in these doubts, but inferred that a part of the remains indicated the former existence of a terrestrial animal which had become extinct, larger than the elephant.[6] Peter

[1] Fischer de Waldheim, Bullet. de la Soc. de Moscou, 1829, tom. i. p. 275; Mémoires de la Soc. de Moscou, tom. i. p. 285.

[2] Eichwald, Nova Acta Acad. Cæs. Leop. Car. Natur. Curios. 1834, vol. xvii. p. 723, tab. 63, figs. 1 and 2.

[3] Morren, Bulletin de la Soc. Géol. de France, tom. ii. p. 231.

[4] As in the case of the Mammoth (*E. primigenius*, Blum.), the specific name given by Blumenbach to the North American mastodon, *M. Ohioticus*, is here adopted instead either of *M. giganteus* or *M. maximus*, the names applied by Cuvier at different times. Blumenbach, in his 'Handbuch der Naturgeschichte,' 1797, had characterized the extinct animal by the form of the teeth, and called it *Mammut Ohioticum*, as a species of a peculiar genus, before the appearance of Cuvier's memoir (Annal. du Mus. tom. vi. p. 260, 1805), in which the designation of *M. giganteus* is first applied. This latter was abandoned (Oss. Foss. 4to edit. of 1824) for *M. maximus*. If the law of priority left a choice, *M. Ohioticus* would still be preferable to either of the names given by Cuvier, as the species is by no means the giant of the family.

[5] Daubenton, Actes de l'Académie des Sciences, 1762; and Histoire Natur. de Buffon, tom xi.

[6] Buffon, Histoire Natur. tom. xi. p. 86.

Collinson, in the 'Philosophical Transactions' for 1768, gave some good figures of the back grinders, and shrewdly observed that the form of their crown was adapted for crushing boughs, twigs, and leaves, betokening the animal to have been of herbivorous habits.[1] William Hunter, struck with the great contrast between the salient enamel ridges of these teeth and the narrow plated flat surface in the grinders of the elephant, inferred the American fossil to have been a gigantic carnivorous animal, which he proposed naming *Pseudelephant.*[2] The great reputation so justly attaching to the name of Hunter gave undue weight and a wide currency to this very erroneous opinion, and further led to the mammoth of Siberia being commonly confounded under the same carnivorous notion with the mastodon of North America.

Peter Camper, in the first instance, made a considerable step towards an accurate knowledge of the extinct animal, by the inference that its molar teeth had a greater analogy with those of the elephant than of the hippopotamus; and that, like the former, it was probably invested with a trunk and with tusks;[3] but he afterwards expressed doubts which compromised the value of his original observations, having been led to adopt the opinion of Michaëlis, that the animal belonged to the order *Bruta* of Linnæus; that it had no tusks, and differed greatly from the elephant.[4] This error, as has been explained by Cuvier, arose from the inspection of a detached palate with grinders, the posterior part of which was mistaken, both by Michaëlis and by Camper, for the anterior.[5]

Pennant first ventured, in 1793, to designate the American fossil animal in a systematic work as a species of elephant, by the name of *E. Americanus*; and Blumenbach, in 1797, erected it into a kind of genus, under the name of *Mammut Ohioticum*, which he briefly characterized by the form of the teeth. Cuvier, in his earliest memoir on the elephant, described it also as a species of this genus under the specific designation applied by Pennant of *E. Americanus*,[6] for which Adrian Camper, entertaining the same opinion of its generic relations, proposed the substitution of *E. macrocephalus*.[7] But in his second extended and elaborate memoir, published in 1805, which formed the groundwork of what he has

[1] Collinson, Phil. Trans. 1768, vol. lvii. p. 469.

[2] W. Hunter, Phil. Trans. vol. lviii. p. 38.

[3] Camper, Acta Petropolit. tom. i. part 11, p. 219.

[4] *Idem, loc. cit.* tom. ii. p. 259.

[5] Oss. Foss. tom. i. p. 212.

[6] 'E. Americanus, molaribus multicuspidibus lamellis post detritionem quadrilobatis.' Cuvier, Mém. de l'Institut. Ann. vii. (1798). 'Sur les espèces d'éléph. viv. et foss.' p. 21.

[7] A. Camper, 'Descript. Anatom. d'un éléphant mâle,' avant-prop. Note, p. 10.

written on the subject in the 'Ossemens Fossiles,' Cuvier separated the elephants with mammillated molars from the ordinary forms with lamelliform molars, and united the former into a genus which he designated *Mastodon*, taking the North American species, under the name of *M. giganteus*, as the type.[1] In the interval between these two memoirs, Peale made the important discovery of two skeletons of the Ohio Fossil, near the banks of the Hudson River, in the State of New York, one of which was brought to Europe in 1802, and furnished nearly complete materials for instituting a detailed comparison between the osseous frame of the mastodon and of the existing elephants.[2] Cuvier pointed out the entire correspondence between them in the tusks, trunk, and the whole of the skeleton, except the molar teeth. He admitted, even in regard to the latter, that the difference between the transverse mammillated ridges of the mastodon and the thin plates of the elephants is merely one of proportion; but insisted that there is an essential distinction in the circumstance that the spaces between the enamel ridges are filled with 'cement' in the teeth of the elephant, which is wanting in those of the mastodon. In addition to this supposed difference, he found corresponding modifications in the form of the cranium, which confirmed him in his view of a well-marked generic distinction between *Mastodon* and *Elephas*.[3] In the same memoir, Cuvier characterized four other species of his new genus, viz. *M. angustidens*, in which he included all the narrow mastodon molars found in Europe, together with some from America, two species from South America, *M. Andium* and *M. Humboldtii*, and a small European species, which he named *M. minutus*. To these was subsequently added, in the 'Ossemens Fossiles,' a sixth species, under the name of *M. Tapiroïdes*.

In regard to the number and succession of the teeth, while he admitted eight molars on each side of both jaws to the elephant, this great anatomist, not hazarding a conjecture beyond the materials which had come under his eye, was not aware of more than four on each side in the mastodon, or sixteen in all. He was also without the knowledge of the occasional presence of tusks in the lower jaw; but he first made the important observation, that in the *Mastodon angustidens* a part of the anterior series of molars in the upper jaw is replaced by a vertical successional tooth, or true premolar, thus bringing them under the normal law of the order of

[1] Annales du Muséum d'Histoire Naturelle, tom. viii. 'Sur le grand Mastodonte.'

[2] T. R. Peale, 'Account of the Skeleton of the Mammoth,' &c.; and 'Historic. Disquisit.' 1802 and 1803.

[3] Oss. Foss. tom. i. p. 221.

Pachydermata, by showing a division into a milk and permanent set. The Dax specimen, figured in the 'Ossemens Fossiles,'[1] clearly establishes this point; and the signification of the structure is distinctly, although guardedly, explained by Cuvier in the descriptive part of the work.[2] But he was less happy in the definition of his species. Under the name of *Mastodon angustidens* he has included two very distinct forms, characterized by a different numerical formula in the crown ridges, viz. *M. angustidens* and *M. longirostris*; and the South American teeth which he distributed among three nominal species, *M. angustidens*, *M. Andium*, and *M. Humboldtii*, appear to be all referable to a single form, *M. Andium* of M. de Blainville. We agree also with the latter authority, in considering the tooth upon which *M. minutus* is founded to be nothing more than an anterior molar of a young *M. angustidens*.

Cuvier's opinion was first called in question by Tilesius, in 1815, in his memoir upon the skeleton of the frozen mammoth, discovered by Mr. Adams in Siberia.[3] He repudiates the validity of the grounds for separating mastodon from elephas, in terms of such strong dissent as to have excited the indignation of the French philosopher:[4] 'Cuvierus in tractatu suo de hac specie (M. giganteus) quam injuste ab elephantorum genere separavit quamquam non solum dentes molares, in quibus male genericam diversitam[5] quæsivit lamellosæ sunt structuræ, ut omnes reliqui elephantorum molares sunt, sed etiam totum animal characteribus genericis elephantorum respondeat ejusdem opinionis est.' Cuvier's division, however, has been adopted by every subsequent writer except M. de Blainville, who coincides with the view taken by Tilesius.

A still more important oversight was made by the founder of the genus, in regard to the statement which he advanced of the entire absence of 'crusta petrosa,' or 'cortical' from the molars of mastodon. It is true that this substance is not present in an appreciable quantity in *M. Ohioticus*, and that it is also but very sparingly developed in *M. angustidens* and *M. longirostris*; but, in *M. Andium*, a typical form of the genus, this substance exists in a layer of considerable thickness, which we have observed in almost all the teeth of the species, contained in the museum of the Jardin des Plantes, including the specimens brought by Dombey, Humboldt, and Gay, from Chili and Peru, and also in the rich series of

[1] Divers Mast. pl. iii: fig. 2.
[2] Tom. i. p. 256.
[3] Tilesius, Mém. de l'Acad. Impériale des Sciences de St.-Pétersbourg, tom. v. p. 452.
[4] Oss. Foss. tom. i. pp. 11 and 225.
[5] *Sic* in orig.

specimens from Buenos Ayres, lately acquired by the British Museum. The great weight of Cuvier's authority has given an undue influence to his statement upon this point, which has biassed the observations of some later writers directed to the subject.

No other additions were made to the species of *Mastodon* from the second edition of the 'Ossemens Fossiles' until 1826, when an important discovery was made of fossil bones, along the banks of the Irrawaddi River, in the Burmese Empire, by Mr. Crawfurd. These remains have been figured and described in the 'Geological Transactions,' by Mr. Clift, who has made a valuable contribution to palæontology by proving the existence of two Indian fossil species, which, through the form and number of the coronal divisions of the molars, establish connecting links between *Elephas* and *Mastodon*. These he has named *M. Elephantoïdes* and *M. latidens*, and from their examination, he was led, with prescient sagacity, to anticipate the discovery of other forms which should constitute a complete transitional series between the two genera.[1] But Mr. Clift, like Cuvier, overlooked the presence of a coat of 'cement,' which is developed in such thickness in one of the species (*M. Elephantoïdes*) as to be of functional importance; and his two nominal species include teeth which appear to belong to several distinct forms.

The next accession to the species of Mastodon was made in 1828, by Croizet and Jobert, who described certain fossil teeth and jaws from Auvergne, under the name of *M. Arvernensis*.[2] The specimens were chiefly jaw fragments, derived from very young animals, and the species was characterized by these palæontologists, as distinguished from the true *M. angustidens* of Cuvier, by the presence of a well-developed front and back 'talon' in each of the molars, and by the greater complexity in the composition of the crown ridges, which are irregularly subdivided into aggregations of small warty cones.

The observations of Croizet and Jobert were correct, so far as they went, and to them assuredly belongs the merit of having first recognised the distinctness of this much-disputed species, which is most frequently met with in authors under the name applied to it by Kaup of *M. longirostris*.[3] But the most essential distinctive character escaped their notice. In the year following the publication of their work, Hermann von

[1] Clift, Geol. Trans. 2nd Ser. vol. ii. p. 369.

[2] Croizet et Jobert, 'Recherch. sur les Oss. Foss. du Départ. du Puy-de-Dôme,' 1828, p. 133.

[3] *MS. Note by Dr. F.* 'This mistake was subsequently corrected in the published plates of the Fauna Antiq. Siv., where *M. longirostris* and *M. Arvernensis* are shown to be distinct.' See also memoir on Mastodon in vol. ii.

Meyer described under the same name a fragment of the upper jaw of a young mastodon, from the celebrated deposit of Eppelsheim, containing the three first molars *in situ*.[1] After considering the characters indicated by Croizet and Jobert, he states that *M. Arvernensis* is distinguished from *M. maximus* (M. Ohioticus), *M. angustidens*, and all the other species then known, by the circumstance that the third molar in the order of antero-posterior succession has the crown divided into *four* ridges, while the same tooth in the other species presents only *three* ridges. In a subsequent memoir, on the fossil remains of Georgensmünd,[2] von Meyer figured and described several mastodontine grinders, which he referred to the true *M. angustidens* of Cuvier, and which confirmed the constancy of the differential character between that species and *M. Arvernensis*, in the numerical division and form of the crown ridges, as pointed out by him in his previous memoir. This was the first step towards a satisfactory determination of the species, as distinct from *M. angustidens*; and a great mass of additional materials, confirming the same inference, was soon afterwards brought to light by Dr. Kaup; but, in the interim, new observations, of great interest, were made upon the mastodon of North America, which gave an entirely different character to the investigation from this date.

No suspicion appears to have been entertained before this time, that any of the mastodons, more than the existing elephants, possessed tusks in the lower jaw. Cuvier expressly affirms their absence;[3] although, as has been observed by Professor Owen,[4] he figured in the original memoir in the 'Annales du Muséum,' and in the first edition of the 'Ossemens Fossiles,' a lower jaw of an adult *Mastodon*, showing what appears to be the alveolus of a persistent inferior tusk. Early in 1830, a memoir by Dr. Godman was read to the American Philosophical Society,[5] upon a mastodontoid lower jaw, with two small tusks, which he described as characterizing a distinct proboscidean genus, under the name of *Tetracaulodon*. This jaw belonged to a young animal, and showed four molars on each side, the anterior two of which Godman considered to belong to the 'milk,' and the rest to the permanent series. These teeth resembled, in every respect, molars of the same size, in other specimens of the

[1] Hermann von Meyer, 'Ueber Mastodon Arvernensis bei Eppelsheim.' Nov. Act. Acad. Leop. Carol. Natur. Curios. 1829. Vol. xv. p. 113.

[2] Museum Senckenbergianum. Die fossilen Zähne und Knochen von Georgensmünd, 1834, p. 33, tab. 1 and 3.

[3] Oss. Foss. tom. i. p. 233.

[4] Owen, 'Odontography,' p. 619.

[5] Godman, 'Americ. Phil. Trans.' New Ser. vol. iii. p. 478. 'Tetracaulodon Mastodontoïdeum.'

lower jaw, which exhibited no vestige of a tusk, and which were usually considered to belong to *M. Ohioticus*. Mr. W. Cooper, in consequence, immediately questioned the accuracy of Godman's inference, and insisted that the inferior tusks indicated merely differences dependent on age and probably sex; that they were possessed by the young animals, but were shed during the increase of age, the period of their fall varying with the individual.[1] Mr. Titian Peale suggested that these inferior tusks might be a distinctive mark of young males.[2] Dr. Harlan adopted the same view,[3] and referred to the corneous appendages in several genera of the Ruminantia as analagous distinctive characters between males and females. Notwithstanding the force of these objections, Dr. Isaac Hays, in 1831, not merely maintained the correctness of Dr. Godman's opinion regarding the distinctness of *Tetracaulodon*, but attempted to distinguish two additional species of this nominal genus under the titles of *T. Collinsii* and *T. Godmani*, besides two new North American species of *Mastodon*.[4] The memoir in which these opinions were advanced is illustrated by an excellent and copious series of figures, exhibiting the dentition of *M. Ohioticus*, from a very early to the adult stage; and although Dr. Hays has entirely failed in sustaining the genus *Tetracaulodon*, or the species which he proposed, his memoir has served as an important contribution to palæontology, by showing that the number of molars developed during life, in *M. Ohioticus*, successively from behind, amounts to six. These he has traced from the first to the last with great care, in the lower jaw, and established the position and characters of each by the comparison of a large number of specimens.

Whilst this discussion was taking place in America, the discovery was made of a similar structure in a European species of *Mastodon*, by Dr. Kaup. This distinguished palæontologist first proved the existence of two deflected and recurved tusks of large size, in the lower jaw of his colossal genus *Dinotherium*, the teeth of which had been referred by Cuvier to a gigantic kind of Tapir. Soon afterwards, at Eppelsheim, in the same arenaceous deposit which had yielded the Dinotherian remains, he discovered an adult lower jaw of a species of *Mastodon*, which presented a remarkable semi-cylindrical and beak-shaped elongation of the

[1] W. Cooper. 'Lyceum of Nat. History of New York,' April 1830; 'Silliman's Journ.' vol. xix. p. 159; and Featherstonhaugh's 'Monthly American Journ. of Geol.' vol. i. p. 158.

[2] Titian R. Peale, quoted in Dr. Hay's Memoir, Amer. Phil. Trans. New Ser. vol. iv. p. 318.

[3] Harlan, 'Med. and Phys. Research,' p. 254.

[4] Hays, *loc. cit.* pp. 317–337.

symphysis, forming the sheaths of two inferior tusks, while the molar teeth exhibited the characters attributed by Cuvier to a portion of the specimens included by him under the names of *M. angustidens*. Kaup, after recognising the structure, at first adopted Godman's genus for the reception of his species, which he named *T. longirostris*;[1] but, subsequently, in his great work upon the Eppelsheim fossils,[2] he admitted the force of the objections raised by the American naturalists against the generic importance of the inferior tusks in *Tetracaulodon*, and referred the Eppelsheim fossil to the genus *Mastodon*, retaining the same specific name. He extended the observations made by von Meyer on *M. Arvernensis*, which he considered to be the young of *M. longirostris*. He traced the dental succession from the earliest to the adult stage confirming the observations made by Hays on *M. Ohioticus*, by showing that six molars are developed in the European species during life, in antero-posterior succession. Kaup also detected the presence of an upper premolar, situated as a germ above the second deciduous grinder, in a young specimen of *M. longirostris*, corroborating the inference drawn by Cuvier from the Dax specimen of *M. angustidens*; but he considered this tooth as the normal successor of the first milk molar, the second of the series being the tooth which it specially replaces. Dr. Kaup, in the first instance, took a peculiar view of the affinities and systematic relations of his most remarkable genus *Dinotherium*; but he has since come round to the opinion advanced by other observers, that it was a true pachydermatous form,[3] closely allied to *Mastodon*.

The discussion respecting *Tetracaulodon*, which had been suspended in America, was renewed in England on the occasion of Koch's public exhibition of the entire skeleton, and other remains of the North American *Mastodon*, in London, during 1841. The ingenious exhibitor contrived a fanciful reconstruction of the skeleton inconsistent with the principles of animal mechanics. The huge tusks, instead of being placed with their points directed upwards, as in the elephant, or downwards, as had been formerly suggested by Mr. Rembrandt Peale,[4] were spread out horizontally with diverging curves, so as to resemble two great sickles. Other corresponding extravagancies were exhibited in the apposition of the limbs, and for the grotesque form so constructed, Mr. Koch proposed a distinct generic place, under the desig-

[1] Isis, 1832, p. 628.
[2] Ossemens Fossiles de Darmstadt, 1835, part iv. pp. 65-89.
[3] Akten der Urwelt, 1841.
[4] Cuv. Oss. Foss. tom. i. p. 239.

nation of *Missourium*.[1] Professor Owen, on this occasion, reviewed the whole of the evidence respecting *Tetracaulodon*, and, in a masterly communication to the Geological Society, extended the objections urged by the American naturalists, by numerous and forcible analogies drawn from the dentition of the Dugong and Narwahl, besides some of the ordinary Pachydermata.[2] He arrived at the conclusion that the Mastodontoid animals of North America are all strictly referable to a single species, which 'has two lower tusks originally in both sexes, and retains the right lower tusk only in the adult male.' Dr. Grant entered upon an elaborate investigation of the same subject soon afterwards, and was led to very different results.[3] He divides the proboscidean pachydermata into four genera, *Elephas*, *Mastodon*, *Tetracaulodon*, and *Dinotherium*, to each of which he attributes a different dental formula. He admits thirteen species of *Mastodon*, and discriminates six species of *Tetracaulodon* among the mastodontoid animals of North America. Mr. A. Nasmyth adopted similar views, from a minute microscopical examination of the structure of the tusks in these extinct animals;[4] but the importance of the differential marks indicated by Dr. Grant and Mr. Nasmyth has not been admitted by subsequent observers, as characterizing more than individual and sexual varieties in different animals of the same species. The generally received opinion at present is that *M. Ohioticus* is the only mastodontoid form hitherto met with in North America.

In the additions to the last edition of the 'Ossemens Fossiles,' Cuvier has recorded the discovery of fossil grinders of mastodon, in the Lignite beds of Kœpfnach and Ellg in Switzerland, which he has referred to his 'Mastodonte à dents étroites.'[5] Some of these remains have been described by Schinz as indicating a distinct species for which he has proposed the name of *M. Turicensis*.[6] M. de Blainville refers them to *M. Tapiroïdes*, as defined in the 'Ostéographie.'

[1] Koch has lately published a separate memoir, in which the *Missourium* is figured and perpetuated with all its original exaggeration. He has given it the appropriate specific name of *M. theristocaulodon* the tusks being invested with the functions of a sort of scythe.—A. C. Koch, 'Die Riesenthiere der Urwelt oder das neu entdeckte Missourium theristocaulodon und die Mastodonten im Allgemeinen und Besondern.' Berlin, 1845.

[2] Owen, 'Proceedings of the Geol. Soc.' Feb. 1842, vol. iii. p. 659; 'Report on the Missourium.

[3] Grant, *loc. cit.* June 1842, p. 770, 'On the Structure and History of the Mastodontoid Animals of North America.'

[4] Nasmyth, *loc. cit.* June 1842, p. 775, 'On the Minute Structure of the Tusks of Extinct Mastodontoid Animals.'

[5] Oss. Foss. 8vo. edit. 1834, tom. ii. p. 366.

[6] Schinz, quoted in von Meyer's 'Palæologica,' 1832, p. 72, and in Bronn's 'Jahrbuch' of 1839, p. 2; mentioned in Jameson's Edin. New Phil. Jour. vol. v. 1828, p. 273, as a communication to the Helvetic Soc. of Nat. Hist. in August, 1837.

Two species of Mastodon have been proposed by Eichwald, from remains found in Poland, under the names of *M. Podolicus*[1] and *M. intermedius*;[2] the former of which appears to be founded on a disguised fragment of the lower jaw of *Dinotherium giganteum*, and the evidence adduced in support of the latter is insufficient as yet to establish its specific independence. M. de Blainville refers it to *M. Tapiroïdes*.[3]

One of the authors has described some of the remains of a typical species of Mastodon, from the tertiary deposits of India, under the name of *M. Sivalensis*,[4] a detailed account of which will be given in this work.

Professor Owen has proposed the provisional name of *M. Australis*,[5] for a form which rests upon a solitary specimen, brought from Australia. We shall have occasion to refer to this specimen in the sequel.

The grounds upon which Cuvier technically rested his generic distinction between *Mastodon* and *Elephas* having been invalidated by the discovery of the species named *M. Elephantoïdes* by Clift, it became necessary for systematic authors either to unite them under a single generic name, or to devise other diagnostic characters for their separation. Bronn, in his 'Lethæa,' gives an elaborate definition of the two genera, founded upon the observations of his countrymen, Kaup and von Meyer, on the European species, and of the American naturalists upon *M. Obioticus*. He characterizes *Mastodon*[6] by inferior tusks; by the presence simultaneously of a greater number of grinders in each jaw; and by the expulsion of the anterior tooth in the young animal by a vertically succeeding premolar. The distinctive characters of *Elephas* he defines to be, the absence of inferior tusks; a less number of more complex grinders at one time in the jaws; and the uniform antero-posterior succession of the whole series of molars without a vertical premolar. M. de Blainville, in his great work,[7] has given the most full and detailed account of the species of both genera, that has appeared since the publication of the 'Ossemens Fossiles,' and has endeavoured, by original observation and by the collation of information drawn from every accessible source, to make his memoir a monograph of the subject, brought up to the state of our knowledge at the present day. Having satisfactorily proved that the number of molar teeth, deve-

[1] Vide *supra*, note, p. 45.
[2] Eichwald, 'Zoologia Special.' 1831, vol. iii. p. 361.
[3] Ostéographie, 'Des Éléphants,' p. 259.
[4] Journ. Asiat. Soc. of Beng. vol. v. p. 294.
[5] Ann. of Nat. Hist. xiv. 1844, p. 296.
[6] Lethæa Geognostica, 1838, Band ii. pp. 1233–1240.
[7] Ostéographie, 'Des Éléphants,' Fascic. xvi.

loped in antero-posterior succession in the elephant does not differ from that of the mastodon, as had been previously supposed, he insists that the characters presented by the number as well as by the form of all the parts of the skeleton are alike in both; that the separate bones are so precisely similar that, when met with detached, it is exceedingly difficult to decide whether they belong to mastodon or to elephant; that, as regards the structure of the teeth, there is a series of intermediate gradations forming a passage from the one genus into the other; and that the observed differences in these organs are systematically of no greater signification than as indicative of the kind of vegetable food upon which the several species subsisted.[1] Guided by these views, M. de Blainville has abandoned Cuvier's genus of Mastodon, and, like the earlier observers, he has united it with the elephant, under the common generic name of *Elephas*, of which he forms two sections, *Lamellidontes* and *Mastodontes*. The former includes the elephants proper, viz. the two existing species, with *E. primigenius* doubtfully admitted as a distinct form, and *E. latidens*, under which name he unites the two species *M. Elephantoïdes* and *M. latidens*, described by Clift. Of the second section, comprising the typical mastodons, M. de Blainville admits only four species, viz. *E.* (*Mast.*) *Ohioticus*, *E. angustidens*, *E. Andium*, and *E. Tapiroïdes*, together with *M. Sivalensis* as a doubtfully established species. M. de Blainville's work is illustrated with an admirable series of representations of the osteology and dentition of the different species, and he has made a valuable contribution to the palæontology of the Proboscidea, by defining the character of *M. Andium*, which was distributed among several nominal species by Cuvier. He has also thrown considerable light on *M. Tapiroïdes*, by means of the materials collected by M. Lartet, in the South of France, which he has combined under this specific name with remains derived from different parts of Europe. But there are weighty objections to the rest of the details of this portion of the 'Ostéographie.' Although the consideration of the teeth is of paramount importance in every question connected with zoological arrangement, it is to be remarked that M. de Blainville has nowhere adverted to the occurrence of premolars in the upper jaw of certain species of mastodon, the presence of which—first observed by Cuvier in *M. angustidens*—has been clearly established by Kaup in the young of *M. longirostris*. The author of the 'Ostéographie' describes them as

[1] *Loc. cit.* p. 2.

equally wanting in the mastodons and in the true elephants. With respect to the species, while M. de Blainville has judiciously rejected a great many of the nominal forms which have been proposed on slender grounds, he appears in other cases to have pushed this numerical reduction too far, and to have mixed up under the same name species which are essentially distinct. This remark applies especially to the Indian fossil forms, three or four of which are combined under *E. latidens*; and to the European *M. angustidens*, which, as defined and illustrated in the 'Ostéographie,' includes two separate species.

Professor Owen has been engaged upon the same subject, contemporaneously with M. de Blainville. In addition to the memoir upon the North American mastodon previously referred to, our eminent countryman has discussed the systematic relations of *Elephas* and *Mastodon*, in his 'British Fossil Mammalia,' and in his very valuable work upon the teeth, lately published. In the latter work he has shown, for the first time, that the molar teeth of the elephants and mastodons, while they agree with each other, form no exception from the normal division into sets presented by the ordinary Pachydermata,[1] and that the apparent anomaly in the order of their succession arises from the partial or total suppression of the successional series of premolars. In the former work, after describing the differences in the form of the teeth of the two genera, he adds:—

'A more important difference presents itself when the teeth of the typical species of mastodon are compared with those of the elephants, in reference to their structure. The dentine, or principal substance of the crown of the tooth, is covered by a very thick coat of dense and brittle enamel; a thin coat of cement is continued from the fangs upon the crown of the tooth, but this third substance does not fill up the interspaces of the division of the crown, as in the elephant. Such, at least, is the character of the molar teeth of the first discovered species of mastodon, which Cuvier has termed *Mastodon giganteus* and *M. angustidens*. Fossil remains of proboscideans have subsequently been discovered, principally in the tertiary deposits of Asia, in which the number and depth of the clefts of the crown of the molar teeth, and the thickness of the intervening cement, are so much increased as to establish transitional characters between the lamello-tuberculate teeth of elephants and the mammillated molars of the typical mastodons; showing that the characters deducible from the molar teeth are rather the distin-

[1] *Supra*, p. 51.

guishing marks of species than of genera, in the gigantic proboscidean family of mammalian quadrupeds.

'Two dental characters, however, exist, though hitherto, I believe, unnoticed as such,[1] which distinguish, in a well-marked and unequivocal manner, the genus *Mastodon* from the genus *Elephas*. The first is the presence of two tusks in the lower jaw of both sexes of the *Mastodon*, one or both of which are retained in the male, and acquire a sufficiently conspicuous size, although small in proportion to the upper tusks, while both are early shed in the female. The second character is equally decisive; it is the displacement of the first and second molars in the vertical direction, by a tooth of a simpler form than the second, a true *dent de remplacement*, developed above the deciduous teeth in the upper, and below them in the under jaw.

[1] *Manuscript Note by Dr. Falconer.*—Professor Owen has preferred a claim to having first pointed out the inferior tusks and the vertical premolar as distinctive generic characters between Mastodon and Elephas. His words are: 'I first pointed out the inferior tusks, whether transitory or persistent, as a well-marked generic character of *Mastodon* as contra-distinguished from *Elephas* in my "History of British Fossil Mammalia" (p. 275); and also defined a second character, in the displacement of the first and second molars in the vertical direction by a tooth of simpler form than the second—a true "dent de remplacement," developed above the deciduous teeth in the upper and below them in the under jaw. Both these dental characters, which are of greater importance than many accepted by modern zoologists as sufficient demarcations of existing generic groups of Mammalia, have been recognized in the *Mastodon giganteus* of North America and in the *Mastodon angustidens*, which is the prevailing species of Europe' (Odontography, part iii. p. 615. June 1845). The passage above referred to in the 'British Fossil Mammalia' is thus:—'Two dental characters, however, exist, though hitherto, I believe, unnoticed as such, which distinguish in a well-marked and unequivocal manner the genus *Mastodon* from the genus *Elephas*,' &c., as in the Odontography (British Fos. Mam. p. 274, part vi. 2 Dec. 1844). But both of these characters are expressly mentioned as generic points of distinction between *Mastodon* and *Elephas* by Dr. Bronn, of Heidelberg, in his 'Lethæa,' as far back as 1838, six years before the publication of part vi. of the 'British Fossil Mammalia.' Bronn's elaborate definition of the genus *Mastodon* begins with these words:—'The genus *Mastodon* (of which entire skeletons possessing even, as it seems, the hyoid bone and stomach, have been found in North America) exhibits in the skull, in the tusks, in the number of toes, and in all the characters of the skeleton which admit of an inference as to the nature of the soft parts, no other generic difference from *Elephas*, excepting the sufficiently important ones in the *grinders* and *lower incisors*. The dental formula is thus: $\frac{1}{1} \cdot \frac{0}{0} \cdot \frac{(3-)}{(3-)} \cdot \frac{4}{4}$. The grinders appear in a larger number: namely, there are present in both jaws from 1 to 4 of them contemporaneously, according to species and age, which, as in the elephant, are replaced two or three times; not, as usual, from below upwards (vertically), but as in the latter, by teeth which are pushed from back to front—*excepting, however, the most anterior of these teeth*' (Bronn, Lethæa Geog. Band. ii. p. 1233). Then he defines *Elephas* thus:—'Essential character, $\frac{1}{0} \cdot \frac{0}{0} \cdot \frac{2}{2}$ teeth; viz. a huge tusk in front, and compound grinders behind; a long muscular trunk; five toes before and behind' (p. 1239). In the continuation, giving the general description, he adds:—'The elephant ordinarily has only two grinders in each jaw at one time (in advanced age only one, probably, as in mastodon), which are replaced by others, not, as usual, in a vertical, but *all in a horizontal direction*; and that not only once, but probably three or four times,' &c. (p. 1240). In

'These two dental characters, which are of greater importance than many accepted by modern zoologists as sufficient demarcations of existing groups of mammalia, have been recognised in the species called *Mastodon giganteus*, most common in North America, and in the *Mastodon angustidens*, which is the prevailing species of Europe.'

But the value of these alleged characters, as furnishing certain distinguishing marks between mastodon and elephant, is far from being absolute. It will be seen in the sequel that premolars, instead of being invariably wanting in the elephants, are developed in greater number in one typical fossil species than they are known to be in any ascertained species of mastodon (*Elephas planifrons*); while, on the other hand, they do not appear to be constant in every species of the latter group; and, although the inferior tusks have been observed in three species of mastodon, there are other forms in which they have not yet been detected, even in specimens of the young animal (*Mastodon Sivalensis* and *M. Elephantoïdes* of Clift).

With respect to the European species, Professor Owen considers, like M. de Blainville, that *M. angustidens* and *M. longirostris* belong to a single form; and he refers the whole of the elephantine remains which occur so plentifully in England, whether in the fluvio-marine crag, or in the superficial drift and gravel, also to a single species, *E. primigenius*. He describes the dentition of the Indian species, discovered by Clift, under the designation of '*Transitional Mastodons*.'

We shall now proceed to the special consideration of the teeth, as the organs which have the greatest share of influence in determining the modifications in the construction of the cranium, and in the development of the general form presented by the different species in the Proboscidea.

a note (p. 1218), Dr. Bronn states that: 'Tetracaulodon, according to Kaup, has "*premolars*" in the upper jaw, which are very similar to the back molars of hippopotamus, and are very caducous.' Further, in his remarks upon *Tetracaulodon* of Godman, after stating that the species enumerated by Hays were, according to W. Cooper, Peale, and Harlan, only 'individual varieties in young males of *Mastodon giganteus* of different ages,' he adds, in regard to these inferior tusks: '*Mastodon giganteus*, *M. angustidens*, and *M. longirostris*, do unquestionably possess such inferior tusks; the other species of mastodon occur more rarely, and we can, therefore, only by analogy infer their having possessed them also' (p. 1233). Bronn appears to have founded his diagnosis mainly upon the observations of his countrymen, Kaup and Von Meyer, regarding *M. longirostris*, Kaup (*M. Arvernensis*, Von M.). Nations, as well as individuals, are jealous on points of discovery. We are confident that Bronn's remarks must have escaped the notice of our distinguished countryman when he wrote the passage in the 'British Fossil Mammalia;' and that he will concede priority of observation, on both points, to the German Palæontologists.—[Ed.]

§ 2. On the Structure and Form of the Molar Teeth.

Plates I., II., and III. (F.A.S.)[1] are intended to represent, by careful copies of nature, the modifications in structure and form exhibited by the molar teeth of the Proboscidea; they show, in vertical sections, a series of gradations, commencing with *Dinotherium* and *Mastodon Ohioticus* at one extremity, and running through the other species to *Elephas primigenius*, in which the greatest deviation from the ordinary form of a grinding tooth is met with.

Each molar in the Proboscidea,[2] as is the case with all other animals, is developed within a closed membranous sac, called the capsule, which is lodged in a cavity of the maxillary bone, and which forms the mould, so to speak, of the tooth. The exterior of this sac is simple, while its internal surface is expanded into numerous folds which determine the arrangement of the 'ivory,' 'enamel,' and 'cement,' entering into the composition of the tooth. From the bottom of the sac a gelatinous mass, the 'pulp nucleus,' is projected upwards, subdivided into transverse digitated plates or segments, varying in number, length, and thickness in different species, and more or less numerous in different molars of the same individual, according to the age of the tooth. These 'pulp' segments are attached only by their base, and attenuate gradually upwards to their summits, being entirely free from adhesion, either to the opposite side of the sac or to the contiguous 'pulp' divisions. The ossification of this 'pulp nucleus,' by the deposition of calcareous matter within the cells of its tissue, constitutes the ivory core, or central part of the tooth, being the substance called 'dentine' by Professor Owen.

From the opposite or coronal side of the capsule, other folds or induplications are given off, which proceed into the spaces between the divisions of the 'pulp nucleus.' Their attachment is continued along the parietes of the sac, so that on every side, except the base, they envelope the processes of the 'pulp nucleus,' over which they are closely applied, interlocking with the latter; the two sets of processes thus forming productions from the interior of the sac which are opposed to each other in the manner of salient and re-entering angles. The ossification of these peripheral folds in a continuous sur-

[1] Here and in the remaining portion of this memoir, the letters F.A.S. imply that the plates referred to are to be found in the 'Fauna Antiqua Sivalensis.' When these letters are not appended, the plates are those of the present edition of Dr. Falconer's works.—[Ed.]

[2] The substance of the four following paragraphs is drawn from the admirable descriptions given by Cuvier in the Ossemens Fossiles, tom. i. p. 32, and by Owen in his valuable systematic work on the teeth, Odontography, p. 649.

face constitutes the 'enamel,' or vitreous shell, which encloses the ivory core of the crown of the teeth, terminating abruptly where the fangs commence.

Exterior to, and following the folds of this 'enamel pulp,' there is another modification of the internal membrane of the sac, the ossification of which, during the last stage of the development of the tooth, constitutes the external 'cortical layer,' or 'cement,' which, in a crust of greater or less thickness, is continued over the enamel of the crown and down upon the fangs. In the true elephants this cement substance completely fills up the hollows between the plates of enamel.

The production of the hard tooth takes place by a process of calcification, which commences in the summits of the 'ivory pulp' segments, the solidification extending gradually downwards along the digital processes, which unite into a transverse plate; and these plates, at their base, are combined so as to form the common body of ivory which occupies the central mass of the tooth. Simultaneously with this production of the ivory, a similar process of solidification goes on in the corresponding and continuous portions of the 'enamel pulp,' forming a shell of enamel which is closely applied to, and moulded on the form of, the ivory segments and their digital subdivisions. When the calcification has reached the common base of ivory, the enamel plates covering the contiguous segments of ivory unite along their lines of junction in the bottom of the clefts between the ridges.

The basal mass of the 'pulp nucleus' is not connected in a continuous surface with the bottom of the sac, but, as it were, by pedicles which, after the solidification of the body of the tooth, elongate and become contracted, with more or less of subdivision. These pedicles undergo the same process of calcification, and form the fangs by which the tooth is implanted in the jaws. The fangs bear a relation to the divisions and vertical height of the crown, being few, thick, and more or less distinct in the mastodons, while they are numerous, slender, and confluent in the elephants.

The three constituent dental substances are structurally distinguished by very different characters, and their combined modifications in the molar teeth furnish the best differential marks for the arrangement of the groups of *Mastodon* and *Elephas*, and for the discrimination of the different species.

The molars of the North American mastodon and of the existing Indian elephant may be selected as convenient illustrations of the opposite extremes of form, presented by these teeth in the Elephantidæ. Taking the last tooth of the upper jaw as the example; in the former, the crown is nearly rectangular in outline, somewhat higher in front than behind,

the dimensions being about seven inches in length, by four of width at the anterior end. The height of the crown, from the base of the enamel to the summit of the first ridge (*vide* Section, Pl. VII. fig. 2, or Pl. III. fig. 9, F.A.S.), is about two and a half inches, decreasing a little successively to the fourth or last principal ridge. The grinding surface is divided in two directions, viz. longitudinally along the axis by a narrow cleft, which, as in the hippopotamus and most other pachydermata, bisects it into nearly equal segments; and transversely by four deep open hollows, alternating with as many trenchant ridges. Each of the lateral divisions of these ridges is composed of a pair of compressed confluent points; in the upper molars, the outer division is more elevated and slopes gradually towards the inner side, which, although lower, is the most complex in composition, giving off the 'talons' and accessory tubercles, which are more or less developed in different species, the inner point being commonly the largest. This relation continues during the wear of the teeth, the inner side being more worn by the process of trituration than the outer. The teeth of the lower jaw agree with the upper in the form and subdivision of the crown; but the disposition of the lateral segments is reversed, the inner being higher, and continuing so during the wear, while the outer are lower, but more complex in composition. The higher and lower portions of the crowns of the opposed teeth are thus brought to act against each other, and serve more effectually the triturating function of the teeth. The plane of the grinding surface is nearly level from back to front, both in the upper and inferior grinders. In consequence of the peculiar mode of protrusion of the teeth from behind forwards, the crown ridges come successively into use, commencing with the first, and each of the lateral divisions is ground down to a rhomboidal disc, surrounded by a band of thick enamel: as the wear of the tooth advances, the separate discs unite, forming a wide transverse depression corresponding to the configuration of the ivory nucleus, and the shell of enamel which invests it. The 'cement,' or third dental substance, is very sparingly developed upon the crowns of the molars of the North American mastodon, being only distinguishable in a thin layer under the microscope. It is more abundant upon the fangs. The anterior ridge is supported by two stout united fangs, and the three posterior ridges by fangs agreeing with them in number, but more or less confluent into an irregular hollow cone.

In the existing Indian elephant, the last grinder of the upper jaw is of a subtriangular rhomboidal form in the vertical section, widely different from that of the North American

mastodon. The crown is very high in front, and declines rapidly behind. In a large specimen of this tooth from Assam, the dimensions are upwards of fourteen inches of length by eight inches of height in front, which is reduced to about one-third at the last ridge, while the width does not exceed three inches at the anterior end, from which it narrows gradually behind. The coronal surface is convex across, and also in the antero-posterior direction. There is no indication of the longitudinal cleft, which, in the North American and other mastodons, bisects the crowns of the molars into lateral segments. The ridges, which in the first-mentioned species do not exceed four, are multiplied in the last upper grinder of the Indian elephant to twenty-three or twenty-four thin plates, which terminate upwards in slender, cylindrical digitations, hence called *Cheirolites* by the early palæontologists, when found separate. The cement substance enters largely into the composition of the tooth, being interstratified with the enamel plates in a layer which also envelopes the entire body of the tooth. The fangs are slender and numerous, bearing a relation to the lamellæ, but they are confluent into large hollow groups, which are of inconsiderable length, as the tooth is held firm in the jaw by a large portion of the crown being imbedded in the alveolus. Instead of being protruded in a nearly horizontal direction, as in the North American mastodon, the teeth move forwards in the arc of a circle; the anterior plates in the upper grinders are inclined forwards, and by the process of wear they are ground down, so that the front part of the tooth is truncated obliquely, as shown in (Pl. V. fig. 2 (Pl. I. fig. 2, and Pl. VII. fig. 4, F.A.S.), long before the posterior lamellæ come into use. The plane of detrition makes a large angle with the unworn plane of the crown, and in the upper grinders it slopes from the inside outwards, being the reverse of what takes place in the mastodons. In the lower jaw the crown of the last molar is concave from behind forwards, and convex across; the grinding plates, especially towards the posterior end, recline backwards, and the plane of wear, which is concave, slopes from the outside inwards, bearing a reversed relation to that of the upper jaw. The side of the jaw to which the teeth belong is readily distinguished by these characters, and by the circumstance that the upper grinders are convex on the outer, and concave on the inner side, the reverse taking place in the grinders of the lower jaw. The last inferior molar attains a length of fifteen inches, and presents occasionally as many as twenty-six or twenty-seven constituent plates in the largest sized individuals of the Indian elephant.

When the teeth come into use, the digitated summits of

the anterior ridges are first ground down into circular rings of enamel enclosing a pit of ivory; these rings then unite into oval groups (Pl. VII. fig. 4 *a*, F.A.S.); and as the wear descends below their point of separation, the smaller discs disappear in a common transverse band which is bounded by a projecting edge, or *machœris* of enamel. These edges, which represent a transverse section of the enamel plates, either run across in straight and parallel lines, or they are minutely crimped and undulated, or dilated into round loops, or angular expansions in the middle of the ridge: such modifications holding with great constancy in the different species, and yielding the characters by which they are most readily distinguished. The three constituent dental substances being of unequal hardness, are worn unequally by the process of trituration; the hard enamel projects above the ivory, and the softer cement wears more quickly than either. The grinding plane of the tooth thus presents, throughout its period of duration, a surface highly organized by natural inequalities, to serve a constant triturating purpose. As the anterior lamellæ are worn down, the corresponding fangs are gradually absorbed.

Between these extremes, furnished by the North American mastodon and the existing Indian elephant, there is a series of intermediate forms, which establishes an almost unbroken passage from the one into the other.

Fig. 1, Pl. IV. (fig. 6 *a*, Pl. II., F.A.S.[1]) represents a vertical and longitudinal section of the last upper molar of an Indian fossil species, which we have named *Elephas insignis* in this work. It is selected as furnishing the best illustration of the intermediate type of a proboscidean molar tooth, from which those of the other species diverge in opposite directions. It is in the most favourable state of age and use for showing the characters, the four anterior ridges being affected by wear, and the six posterior ridges entire, while the fangs are fully developed, their mode of implantation in the jaw being distinctly shown. The tooth is convex from back to front, in the outline of the crown. The white mass in the centre represents the body of ivory, which is projected upwards in ten angular lobes terminating in a sharp edge. The height of these lobes does not much exceed the width of their base, and closely applied over them is seen a thick layer of enamel, reflected up and down in a continuous zig-zag plate. The interspaces of the five posterior ridges of enamel are completely filled up by a mass of cement, or 'cortical,' much exceeding the enamel in thickness, and in quantity in nearly as great an amount of development as the ivory core of the

[1] See *note*, p. 79.—[Ed.]

ridge. This tooth belongs to one of the forms which have been included under the name of *Mast. Elephantoïdes*, by Mr. Clift, and which Professor Owen names 'Transitional Mastodons.' It is important to observe the characters presented by the cement in this case, as its supposed absence or presence in the molar teeth was the principal character upon which Cuvier rested his generic distinction between *Mastodon* and *Elephant*. Professor Owen, in his 'Odontography,' states, in regard to the teeth of this species, that 'the interspaces are not filled with cement, as in the true elephant: only a thin layer of that substance is continued upon the unworn enamel, as in the true mastodons.'[1] But this statement must be received with some modification. [Fig. 7, Pl. VI., F.A.S., represents a portion of the same section drawn to the natural size, and comprising the sixth and seventh ridges. The cement exhibits an appearance of lamination, of which from nine to eleven layers may be counted, and is developed in as great a quantity as the intervals between the ridges could admit of.] The four anterior ridges have been well used, so that the two first are worn down to a common disc, from which the enamel has disappeared; and the cement of the four anterior hollows, being the softest of the tooth substances, has been completely, or partially, worn away by the same process of detrition. The dark granulated shade below the portion of the ivory nucleus which sustains the five posterior ridges indicates, in the figure (Pl. IV. fig. 1), the hollow of their common posterior fang, which is occupied in the fossil by a core of sandstone; the same matrix also fills the cells of the maxillary bone. The anterior simple fang is shown in the section, of much smaller size. This tooth measures 10·3 inches in length.

Fig. 6 *b*, F.A.S., represents a similar section of the anterior portion of an adult tooth of the lower jaw of the same species. In this instance the two front ridges only have been touched by wear. Instead of being convex, the common curve of the crown is slightly concave. The ivory, enamel, and cement present the same characters as in the upper molar, except that the cement in the interspaces is less considerable in quantity, although sufficiently abundant to indicate that it was functionally serviceable in the grinding operation of the tooth. The posterior part of the basal portion of the pulp nucleus had not yet completed the stage of calcification, its place being occupied in the fossil by a nest of calcareous crystals, bounded in the figure by the undulated line. The figure shows also a portion comprising the two last ridges of the preceding molar, with their common fang implanted in the lower jaw.

[1] Odontography, p. 624.

DESCRIPTION OF PLATE IV.

ELEPHAS INSIGNIS, ELEPHAS PLANIFRONS, AND ELEPHAS AFRICANUS.

Vertical longitudinal sections of teeth of *Elephas insignis*, *E. planifrons*, and *E. Africanus*. Copied from drawings by Mr. Ford in Plate II. of the Fauna Antiqua Sivalensis; one-third of the natural size.

Fig. 1. Is a section of the last upper molar of *Elephas insignis*, copied from Plate II., fig. 6 *a*, of the Fauna Antiq. Siv. The specimen is in the British Museum. (See page 73.)

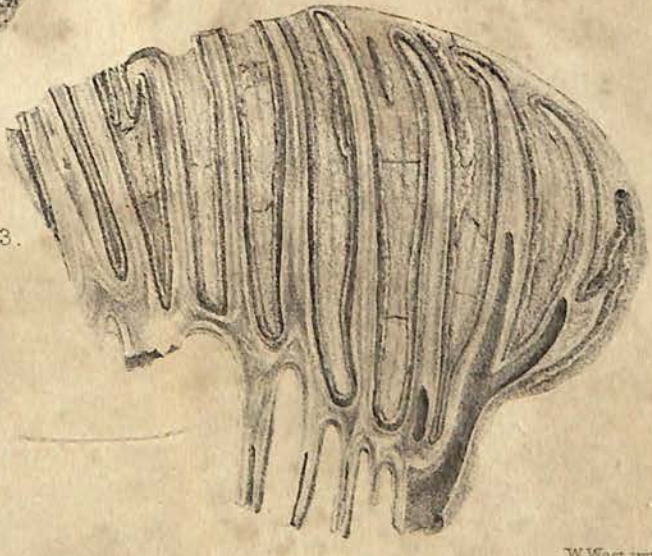
Fig. 2. Is a section of the penultimate upper molar of *Elephas planifrons*, copied from Plate II., fig. 5 *a*, of the F. A. S. The specimen is in the British Museum. (See page 75.)

Fig. 3. Is a section of the penultimate upper molar of *Elephas Africanus*, copied from Plate II., fig. 4 *a*, of the F. A. S. (See page 75.)

Fig. 1.

Fig. 2.

Fig. 3.



G.H. Ford del. J. Dinkel lith.

W. West imp.

1. Elephas insignis. 2. E. planifrons. 3. E. Africanus.

The next serial modification in the disposition of the three dental substances, and in the consequent form of the teeth, is exhibited (in fig. 5 *a* of the same plate, F.A.S.) in Plate IV. fig. 2, which represents a section of the penultimate upper molar of another Indian fossil species, which we have named *E. planifrons*. This tooth shows nine ridges, the three anterior of which alone have been in use, the two first being worn down to a single disc of ivory. The common nucleus of this substance is of less thickness than in the corresponding tooth of *E. insignis*, and the divisions which are continued upwards from it into the centre of the ridges are more elongated, with a narrower base, forming irregular-shaped wedges. The layer of enamel is diminished in thickness and is less uniform in outline, and the surface in contact with the cement shows a feathered or ragged edge, indicating superficial inequalities for the firmer cohesion of this latter substance. The enamel is reflected over the ridges of ivory, and down into the hollows zig-zag wise, exactly as in fig. 1, the principal difference being that the ridges are narrower, with a greater vertical height. The cement substance attains its maximum of development in this species, completely filling up the wide interspaces of the ridges, over which it is continued in a thick mass. This tooth measures 8·7 inches in length.

Fig. 5 *b*, F.A.S., represents a corresponding section of a portion of the last molar of the lower jaw of the same species, comprising nine ridges. This tooth had been longer in use than that of the upper jaw, and all the ridges are more or less worn, except the two last. It presents the same general characters exhibited by fig. 5 *a* (Pl. IV. fig. 2), in the elongated cuneiform ivory ridges, unequal enamel, and abundant cement, the differences being merely such as constantly hold between molars of the upper and lower jaws and of different ages, in the same species.

The existing African elephant furnishes another link in the chain of modifications presented by the molars in this family. Plate IV. fig. 3 (Pl. II. fig. 4*a*, F.A.S.[1]) shows a section of the penultimate grinder of the upper jaw of this species, which is composed of nine principal divisions and a subordinate 'talon' ridge, the four anterior of which are partly worn, the rest being entire. The elongation of the ivory segments, which commences in *E. planifrons*, is carried here to a much greater extent. The segments are produced into long narrow wedge-shaped plates, the height of which is many times

[1] We are indebted to the kindness of Mr. Charles Stokes for the specimens which have yielded the sections 4 *a* and 4 *b* (Pl. II. F.A.S.) of the African elephant, the teeth of this species being comparatively rare in English collections.

greater than the width of their base. The interspaces of the plates are proportionally deep and filled up with a copious mass of cement, which completely envelopes the tooth. The quantity of this substance is measured by the proportion which it bears to the other dental materials, and it is seen to be thicker than the ivory plates. The layer of enamel is reflected over the ridges and down upon the hollows, as in *E. insignis*, but it is much thinner, and the attenuation is proportioned to the elongation of the plates. The common basal mass of ivory is greatly reduced in quantity, if compared either with the sections of *E. insignis*, fig. 1, or of *E. planifrons*, fig. 2, there being little more of this substance than is sufficient to establish a common connection between the bases of the segments, and a foundation for the offset of the fangs, which are numerous. The vertical height of the tooth is considerably greater than that of either of the two other described species. The tooth measures 8·7 inches in length.

Fig. 4 *b*, Pl. II., F.A.S., represents a penultimate molar of the lower jaw of the same species in vertical section. Like that of the upper jaw, it is composed of nine cuneiform plates. This tooth had been a long time in use, all the plates except the last being affected by wear. The anterior part of the crown has been ground down to nearly one-third of its original height, so that the enamel divisions between the two anterior ivory plates have disappeared, and the latter are confluent into a common mass. It is not, therefore, in the condition best adapted to show the characters presented by a good section; but it indicates sufficiently the correspondence of the lower with the upper molars, in the disposition, form, and relative proportion of the ivory, enamel, and cement substances. It bears a very close resemblance to the section of the lower molar of *E. planifrons*, fig. 5 *b*, keeping in mind that the latter is taken from an older and larger tooth. They exhibit the same kind of wedge-shaped ivory plates, a similar amount of cement in the interspaces, and an analogous thickness of enamel. The resemblance between the lower, in these instances, is greater than between the corresponding upper molars of the two species. This specimen measures 7·2 inches in length.

If the eye is carried along these sections in succession, it will be readily perceived that they constitute a series of gradations in form conducted from *E. insignis* to *E. Africanus*, through *E. planifrons*. The modifications are effected by the elongation and thinning of the ridge-plates, with a corresponding increase in the depth of the hollows, and in the vertical height of the teeth; by a diminution of the basal mass of ivory; by a greater number of divisions in the same

extent of tooth surface, and a gradual diminution in the thickness of the layer of enamel. Plate V. represents another succession of links which, in like manner, conduct us from the African elephant on to the extremity of the series in *E. primigenius*.

Fig. 1 of Pl. V. (or fig. 3 *a* of Pl. I., F.A.S.) shows a section of the penultimate upper molar of an undescribed Indian fossil species, named *E. Hysudricus* in this work. The tooth is in the middle state of wear, eleven of the thirteen plates of which it is composed having been in use, and the two anterior ridges being worn out. The same vertical disposition of ivory, enamel, and cement is presented as in the African elephant, but the plates are thinner and a greater number of them is included in the same length, nine or ten plates in the latter being developed in the space occupied by thirteen or fourteen plates in the equivalent teeth of *E. Hysudricus*. The plates are also more vertical, the interspaces occupied by the cement are wider in general than the ivory plates which represent very attenuated wedges. The layer of enamel is proportionally thicker than in the African elephant, approaching, in this respect, the teeth of *E. planifrons*, Pl. IV. fig. 2. The vertical height of the tooth is comparatively less in this specimen than in the African species, the difference being compensated by a greater development of the basal mass of ivory. This specimen measures 7·7 inches in length.

A portion of the last molar of the lower jaw of this species is shown in vertical section in fig. 3 *b* (Pl. I., F.A.S.), comprising about fifteen plates. The entire tooth, which is seen in figures 12 and 12 *a* of Pl. VII., F.A.S., *in situ* in the jaw, is more elongated, and includes a greater number of divisions than is usual in the last inferior grinder of *E. Hysudricus*. The same general character, in the disposition and relative proportion of the ivory, enamel, and cement, is exhibited as in the upper molar, Pl. V. fig. 1, bearing in mind that the latter is a younger and consequently smaller tooth. The layer of enamel, however, is thinner than in the upper molar, owing to the unusually large number of developed plates. The ivory segments are curved backwards near their base, and the apices of the posterior plates lean towards the front of the tooth, a disposition which is still more strongly exhibited in the lower teeth of the existing Indian elephant. The granulated dark shade, below the undulated outline of the ivory, indicates a core of sandstone, which occupies the place of the unossified part of the pulp nucleus and of the undeveloped fangs. Both specimens, 3 *a* and 3 *b*, Pl. I., F.A.S., are implanted in portions of the jaws.

The existing Asiatic elephant, *E. Indicus*, furnishes the next modification represented in this plate. Fig. 2, Pl. V. (or fig. 2 *a*, Pl. I., F.A.S.), shows a section of the penultimate upper molar of this species. The gradual attenuation of the plates, successively exhibited from *E. insignis* to *E. Hysudricus*, is here carried to excess, eighteen of these divisions being comprised within the space occupied by about nine in the equivalent tooth of the African species. They are produced vertically in the same proportion, the height of the middle plate being about three-fourths of the entire length of the tooth; they, in fact, represent parallel perpendicular lamellæ, of nearly uniform thickness from the base to the apex, interstratified with layers of cement of nearly the same thickness. The layer of enamel is attenuated into a thin transversely undulated brittle plate, the surface of which is deeply wrinkled with striæ, for the firm cohesion of the cement. The general character of the section is a pectinated arrangement of the lobes like the teeth of a comb, which contrasts strongly with the chevron-formed ridges of *E. insignis*, and the cuneiform plates of *E. planifrons*. The mass of ivory at the base of the tooth is much thinner than in the corresponding molar of *E. Hysudricus*, bearing but a very slender proportion to the height of the tooth; and numerous small and distinct fangs are given off from its inferior edge. This tooth had been some time in use, the anterior part of the crown being worn off as far as the ninth plate. The plane of the truncated portion is very oblique, being inclined nearly at a right angle to the coronal surface of the unworn portion. This specimen is 8·2 inches in length.

Fig. 2 *b*, Pl. I., F.A.S., represents the section of a very fine specimen of the last inferior molar of the existing Indian elephant of Assam, from the collection at the India House. It is an unusually large specimen, showing as many as twenty-seven plates, the anterior twelve of which have been in use. Precisely the same disposition of the dental substances is observed in this case as in the upper grinder, and they are developed in the same relative proportions. The vertical height of the plates is still greater than in the corresponding lower molar of *E. Hysudricus*. The upper surface is concave, and the under very convex. The anterior plates are nearly vertical, while the posterior gradually slope backwards till they become almost horizontal in the hindmost portion, with a corresponding gradual diminution in their height. This is a mechanical arrangement arising from the contracted diameter of the posterior part of the dental canal, in which the back part of the tooth is developed, close under the condyle, the plates being disposed so as to occupy the

DESCRIPTION OF PLATE V.

ELEPHAS HYSUDRICUS, ELEPHAS INDICUS, AND ELEPHAS PRIMIGENIUS.

Vertical longitudinal sections of teeth of *Elephas Hysudricus*, *E. Indicus*, and *E. primigenius*. Copied from drawings by Mr. Ford in Plate I. of the Fauna Antiqua Sivalensis; one-third of the natural size.

Fig. 1. Is a section of the penultimate upper molar of *Elephas Hysudricus*, copied from Plate I., fig. 3 *a*, of the Fauna Antiq. Siv. The specimen is in the British Museum. (See page 77.)

Fig. 2. Is a section of the penultimate upper molar of the existing Indian Elephant, *Elephas Indicus*, copied from Plate I., fig. 2 *a*, of the F. A. S. (See page 78.)

Fig. 3. Is a section of the last upper molar of the Mammoth, *Elephas primigenius*, copied from Plate I., fig. 1, of the F. A. S. The specimen is in the British Museum. (See page 79.)

Fig. I.

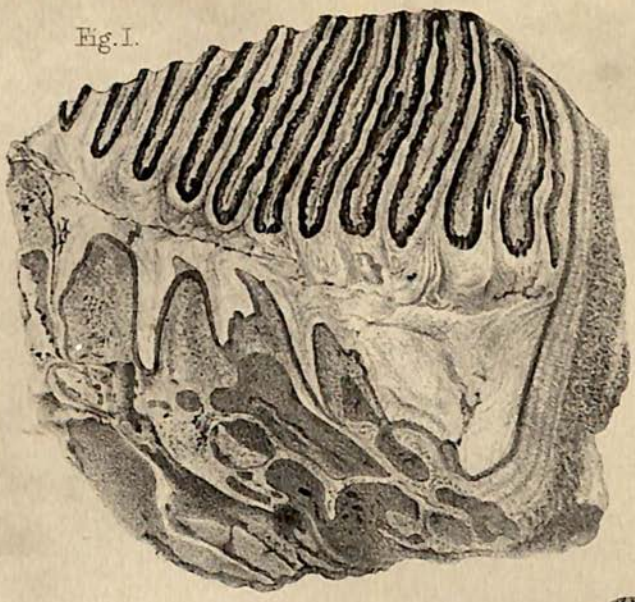


Fig. 2.

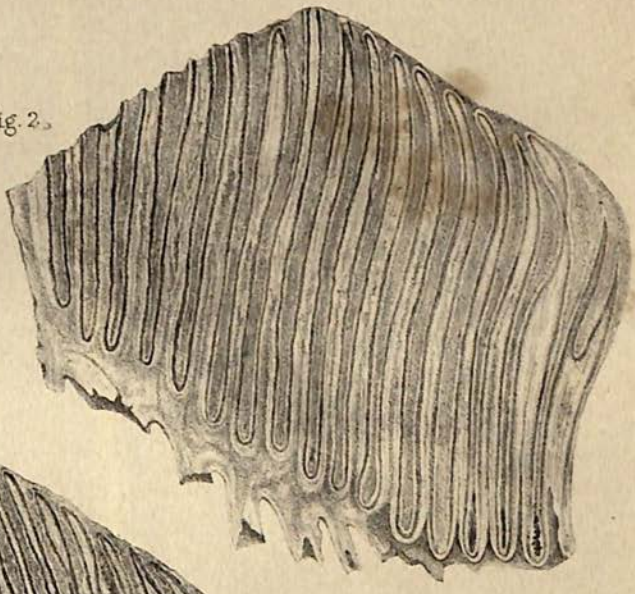


Fig. 3.

G. H. Ford del. J. Binkel lith. W. West imp.

1. Elephas Hysudricus. 2. E. Indicus. 3. E. primigenius.

least vertical space. The basal mass of ivory between the plates and the fangs is reduced to a small quantity. This tooth measures 15¼ inches long in a straight line.[1]

Fig. 3, Pl. V. (or fig. 1, Pl. I., F.A.S.), represents a section of the last upper molar of *E. primigenius*, from an English specimen in the Museum of the Geological Society, found near Kingsland. We arrive here at the last link in the chain of modifications, exhibited by the molar of the typical elephants. The section bears a close resemblance to that of the corresponding tooth of the Indian elephant, but the ivory segments are more vertical, thinner, and more approximated, there being about twenty-two plates in the space occupied by eighteen or nineteen in the latter; and the layer of enamel is still more reduced in thickness. The disposition of the plates presents the extreme degree of 'pectination' seen in the molars of any known species of elephant. The differences observable in the vertical section are, however, so inconsiderable, that, if regarded in this light merely, the mammoth and the Indian elephant might pass for the same species. But when the grinding surface of the crowns of their molars is examined, the transverse plates of enamel in the Indian elephant are seen to be thicker and very closely undulated, with the flexures deeply wrinkled for the attachment of the stratum of cement; while in the mammoth the crowns of the teeth are broader, the enamel plates are thinner and less undulated, so much so that they are frequently described as being transverse and straight. Such at least is the character of the typical form of grinder in *E. primigenius*. This tooth measures ten inches in length, being considerably under the size attained by the largest specimens of the mammoth. It has not been deemed necessary to give a figure of the section of an inferior molar, which differs in no respect from the upper, more than in the case of the existing Indian species.

These are the principal modifications in the construction of the teeth of the elephants. Although, at first sight, the molars of *E. insignis* and *E. primigenius* appear to be very different, the other intermediate forms constitute a series which establishes a passage between them. The species have been traced in a retrograde order, from the simpler to the more complex forms, with the object of making the descriptions more intelligible. It is interesting here to observe how the existing species are intercalated: the serial

[1] The artist has drawn this figure reversed, as compared with the other sections, the worn end of the tooth being to the right. The same remark applies to fig. 6 *a* of Pl. II., F.A.S. In Pl. I., F.A.S., the Indian elephant has been named in the reference *E. Asiaticus* (Blum.) instead of *E. Indicus*.

order of structural development in the teeth does not correspond with the order of succession of the species in time. The extinct mammoth exhibits the greatest amount of complexity, constituting the terminal link of the chain; and next follows the existing Indian elephant, interposed between two fossil species. In like manner, the existing African elephant is placed between two extinct species, *E. Hysudricus* and *E. planifrons*. The figured sections include only the principal forms requisite to establish the passage. Another extinct Indian species, *E. Namadicus* (to be described in the sequel), which is closely allied to the existing Indian form, comes between it and *E. Hysudricus*, together with a European fossil species, which we believe to be distinct from the mammoth; and the gap between the existing African elephant and *E. planifrons* is filled up by another well-marked European fossil species, *E. priscus* (?), Pl. XIV. fig. 7, F.A.S., which is closely allied to the former. This species will also be noticed in a subsequent page.

We shall now revert to *E. insignis*, and endeavour to trace the forms which diverge from it in an opposite direction through the mastodons, the tendency in this series being towards a greater simplicity in the construction of the grinders, and a reduction in the number of coronal segments.

Fig. 1, Pl. VI. (or fig. 7 *a*, Pl. III., F.A.S.), represents a section of the last upper molar of an undescribed Indian fossil species, named *E. Ganesa*, in this work. The crown consists of ten principal ridges, with a subordinate 'talon' ridge in front and behind. The anterior seven ridges have their summits worn, the two in front being ground down to the common base of ivory, the tooth having been a considerable time in use. A small portion is broken off at the anterior end. The disposition and relative proportions of the ivory, enamel, and cement, bear the closest resemblance to those of the corresponding tooth of *E. insignis* (Plate IV. fig. 1), and the number of ridges agrees. The section presents the same chevron-formed character in the ridges, but the interspaces are narrower, the cement is in less quantity, and the layer of enamel is thicker. The common grinding surface of the crown is also less convex. But these differences are so inconsiderable, when taken into account with the range of variation through which the molars run, that they are practically insufficient for the discrimination of the two species. To guard against error, the sections have been taken in both instances from specimens consisting of the palate with a double line of teeth; and, notwithstanding that the molars agree so closely, the crania are remarkably different in the two forms; that of *E. insignis*, Pl. XV., F.A.S., being singularly

modified so as to bear an analogy to the cranium of *Dinotherium giganteum*; while the head of *E. Ganesa* does not differ much from the ordinary type of the elephant. In fact, we have entirely failed in the detection of any good characters by which the teeth of these two species can be distinguished satisfactorily when met with in fragments, as is most generally the case. A similar agreement in the form of the teeth is observable in certain closely-allied species of mastodon. The tooth represented in this section measures nine inches and a quarter in length.

Plate III. fig. 7 *b*, F.A.S., shows a section of one of the posterior molars of a lower jaw, which we infer to belong to the same species. A small portion of the anterior end of the crown has been broken off; but the presence of the anterior fang proves that the section includes the whole length of the tooth except the first ridge, the posterior end being entire. It appears to have consisted of eight principal ridges, with a 'talon' ridge behind, and a subordinate ridge in front. Five of the ridges have been in use, the anterior two in the section being worn down close to the common base of ivory, while the three last ridges are entire. Like the upper molar of *E. Ganesa*, it bears a close resemblance to the corresponding inferior tooth of *E. insignis* (Pl. IV. fig. 1), in the form of the ridges, thickness of enamel, and proportion of cement. This specimen measures about seven inches and a half in length.

The next serial modification in the form of the molars occurs in another extinct Sewalik species, named *E. bombifrons* in this work. It is not included among the sections in Pl. III., F.A.S. This species, of the distinctness of which we are assured by possessing several crania containing perfect teeth, belongs to the same group as the two species last described. The crown is divided into similar transverse ridges, composed of numerous mammillæ, which yield a corresponding chevron-shaped section, and the interspaces are occupied by a thick coat of cement; but they differ, in being broader and less elevated, with more open hollows. The principal ridges of the last molar do not exceed eight in the upper jaw and nine in the lower; while in *E. insignis* they amount to ten in the former, and reach as many as thirteen in the latter. The last tooth of the upper jaw measures eleven inches in length, by four and a half in width. This species will be described in detail in a subsequent chapter.

The same group comprises a fourth extinct Indian species, named in this work *E. Cliftii*, which furnishes the next link in the chain of forms presented by the molars of the Elephantidæ.

It is not figured among the sections in Pl. III., F.A.S. In our view, the tooth represented in Pl. XXXIX. fig. 6, of Mr. Clift's memoir in the 'Geological Transactions,' under the name of *Mastodon Elephantoïdes*, and the palate specimen represented in Pl. XXXVI. of the same memoir, under the name of *M. latidens*, belong to this species.[1] The reasons for this opinion will be given along with the detailed description of the species. The penultimate and antepenultimate molars in the upper jaw have only six transverse ridges, continuous and chevron shaped, with numerous mammillæ, as in *E. insignis* and *E. Ganesa*; but the cement does not fill up the interspaces of the ridges, being reduced to a comparatively inconsiderable quantity in the bottom of the hollows. *E. Cliftii*, in the reduced number of the coronal ridges, and in the other characters of the teeth, appears to constitute the dental link which forms the immediate passage from *Elephas* into *Mastodon*. Mr. Clift, in reference to his *M. Elephantoïdes* and *M. latidens*, has justly remarked that, 'On an examination of the structure of the teeth, this discovery' (viz. of these two species) 'will be found to have still higher claims to attention; for it illustrates the gradual shades of difference by which nature passes almost imperceptibly from one form to another, and helps to fill up the interval which has hitherto separated the mastodon from the elephant.'[2]

The three species last described, along with *E. insignis*, constitute a peculiar section of *Elephas*, of nearly equivalent value to the section which includes *E. primigenius*, *E. Indicus*, and *E. Hysudricus*. That they belong to *Elephas* proper, rather than to *Mastodon*, is clearly indicated by all the principal characters of the teeth: viz. the crowns are divided into many transverse ridges, consisting of numerous mammillæ resembling the digital terminations of the plates in the Indian elephant; the hollows are occupied by a more or less abundant layer of cement; and, as in the typical elephants, there is no appearance of the longitudinal cleft along the axis, which, in almost all the species of *Mastodon*, bisects the crown into lateral divisions. The same direction of affinity is indicated by the characters presented by the crania.

We here take leave, for a time, of the proper elephantine forms; and from this point the complexity in the molars gradually diminishes till they assimilate to the character exhibited by the ordinary Pachydermata.

Fig. 2 of Pl. VI. (Pl. III. fig. 8; F.A.S.) shows a section of another of the specimens described in Mr. Clift's memoir

[1] Geol. Trans. 2nd Ser. vol. ii. p. 369. [2] *Idem, loc. cit.* p. 370.

DESCRIPTION OF PLATE VI.

Elephas Ganesa, Mastodon latidens, Dinotherium Indicum, and Dinotherium giganteum.

Vertical longitudinal sections of the teeth of *Elephas Ganesa, Mastodon latidens, Dinotherium Indicum,* and *D. giganteum.* The three first copied from drawings by Mr. Ford in Plate III. of the Fauna Antiqua Sivalensis, the fourth copied from a drawing by Mr. Scharf in the Quarterly Journal Geol. Soc., vol. i., Pl. XIV., fig. 2 *a*; the first two, one-third, and the last two, two-thirds of the natural size.

Fig. 1. Is a section of the last upper molar of *Elephas Ganesa*, copied from Plate III., fig. 7 *a*, of the Fauna Antiq. Siv. The specimen is in the British Museum. (See page 80.)

Fig. 2. Is a section of the last two upper molars of *Mastodon latidens*, copied from Plate III., fig. 8, of the F. A. S. The specimen was discovered by Mr. Crawfurd in Ava, and is now in the British Museum. (See page 82.)

Fig. 3. Is a section of the penultimate lower molar of *Dinotherium Indicum*, copied from Plate III., fig. 11, of the F. A. S. (See pages 85 & 396.)

Fig 4. Is a section of the penultimate lower molar of *Dinotherium giganteum.* (See pages 85 & 396.)

Fig. 1.

Fig. 3.

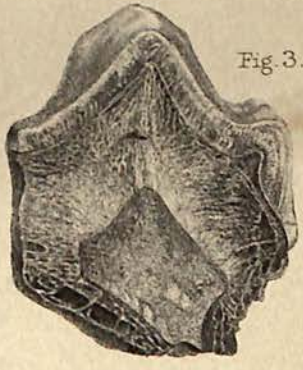


Fig. 4.

Fig. 2.

G.H.Ford del. J.Dinkel lith. W.West imp.

1. Elephas Ganesa. 2. Mastodon latidens. 3. Dinotherium Indicum. 4. D. giganteum.

under the name of *Mastodon latidens*,[1] and represented by him in Pl. XXXVII. fig. 1. It consists of the two last molars of the upper jaw. The figure (in F.A.S.) is drawn on a scale of two-thirds of the natural size. The last tooth shows five principal ridges with a posterior talon ridge and a subordinate ridge in front. The ridges are transverse, and divided by a longitudinal cleft into two pairs of principal points without intermediate mammillæ in the hollows. The enamel is very thick, and the cement is reduced to a thin layer which is only observable in the bottom of the hollows. The ivory lobes resemble those of *E. Ganesa*, Pl. VI. fig. 1, but they are less elevated with a broader base. The artist has been eminently successful in his representation of the texture of the two dental substances in this specimen. The anterior tooth had been a long time in use, and the ridges are nearly all worn out. They were four in number, in this as well as in the two teeth which preceded it in the jaw. We believe this to be a small or dwarf variety of *M. latidens*, a species the adult teeth of which generally attain a large size. The last tooth figured in the section measures 5½ inches in length. *M. latidens*, of the known forms of mastodon, is that which is most nearly allied to *E. Cliftii*, and through that species to the true elephants. One or more intermediate links perhaps still remain to be discovered. It closely resembles the European *M. Arvernensis* (*M. longirostris* of Kaup) in the form of the molars. The correspondence is so great, in the last milk molar and in the antepenultimate and penultimate true molars, that they have been regarded as identical species.

Pl. VII. fig. 1 (Pl. III. fig. 10 *a*, F.A.S.) represents a section of the last molar of the upper jaw of an Indian fossil species named *Mastodon Sivalensis* in this work. The ridges in this species are more complex in their composition than in *M. latidens*. The crown is traversed by a longitudinal furrow which bisects them, each division being composed of a pair of contiguous or connate conical mammillæ, placed more or less alternately. The hollows are in consequence interrupted. This tooth, like its equivalent in *M. latidens*, consists of five principal ridges, with a subordinate ridge in front, and a 'talon' ridge behind. Eight divisions of the ivory may be counted in the figure, the smaller segments arising from the direction in which the section has been made through the alternate mammillæ. The ridges are approximated, and the layer of enamel bears a large proportion to the conical lobe of ivory which it invests. The cement is entirely wanting,

[1] This valuable specimen, discovered by Mr. Crawfurd in Ava, belongs to the collection of the Geological Society, the President of which has liberally allowed a section of it to be made for the illustration given in fig. 8 of Pl. III., F.A.S.

except in the bottom of the clefts. This tooth measures about seven inches in length.

Fig. 10 *b*, Pl. III., F.A.S., shows a section of a fragment comprising the greater part of the last lower molar of the same species. There is a similar alternate arrangement of the mammillæ, and the tooth differs from the corresponding upper molar only in being complicated with an additional ridge.

The teeth of this species bear an exceedingly close resemblance to certain of the European fossil grinders, which have been described under the indefinite name of *M. angustidens*. The three species, *M. latidens*, *M. Arvernensis*, and *M. Sivalensis*, with perhaps a fourth, of doubtful determination, constitute a particular section of *Mastodon*, characterized by the same numerical division of the crown ridges in the last deciduous molar, and in the first and second true molars in both jaws.

Pl. VII. fig. 2 (Pl. III. fig. 9, F.A.S.), as previously described, represents a section of the last upper molar of *Mastodon Ohioticus*. It consists of four principal ridges and a small talon lobe. The successively increasing simplicity of form which has been traced from *E. insignis* attains its extreme limit in the molars of this species. The ridges are transverse, terminating in a trenchant edge; the ivory segments are in regular angular lobes, the layer of enamel is of uniform thickness, and the hollows between the ridges are very wide and open, being almost rounded at the bottom. The cement is present only in an exceedingly thin crust, continued over the fangs in greater thickness. The common plane of the grinding ridges of the crown is nearly horizontal, while it is more or less convex in all the previously noticed species. It has not been deemed necessary to give a delineation of the section of an inferior molar, which differs in no respect from the upper, except in being complicated with an additional ridge.

To the same group belong two other species, *M. angustidens* and *M. Andium*, and probably a third, *M. Tapiroïdes*, the dentition of which is but imperfectly known. The molars of the two first differ from those of *M. Ohioticus*, in the same manner that *M. Arvernensis* and *M. Sivalensis* differ from *M. latidens*; viz. the crown ridges, instead of being transverse, are composed of mammillæ, which are placed more or less alternately, projecting into the interspaces and interrupting their continuity. The teeth of *M. Andium* are remarkable in being invested with a coat of cement, which fills up the bottom of the hollows and is extended over the mammillæ in a considerably greater quantity than occurs in any other species of true *Mastodon*. These three species, *M. Ohioticus*, *M. angustidens*, and *M. Andium*, constitute a

DESCRIPTION OF PLATE VII.

MASTODON SIVALENSIS, MASTODON OHIOTICUS, AND DINOTHERIUM GIGANTEUM.

Vertical longitudinal sections of the teeth of *Mastodon Sivalensis*, *Mastodon Ohioticus*, and *Dinotherium giganteum*. Copied from drawings by Mr. Ford in Plate III. of the Fauna Antiqua Sivalensis; the two first, one-third, and the last, two-thirds of the natural size.

Fig. 1. Is a section of the last upper molar of *Mastodon Sivalensis*, copied from Plate III., fig. 10 *a*, of the Fauna Antiq. Siv. The specimen is in the British Museum. (See page 83.)

Fig. 2. Is a section of the last upper molar of *Mastodon Ohioticus*, copied from Plate III., fig. 9, of the F. A. S. The specimen is in the British Museum. (See page 84.)

Fig. 3. Is a section of the penultimate lower molar of *Dinotherium giganteum*, copied from Plate III., fig. 12, of the F. A. S. The specimen is in the British Museum. (See page 85.)

Fig. 1.

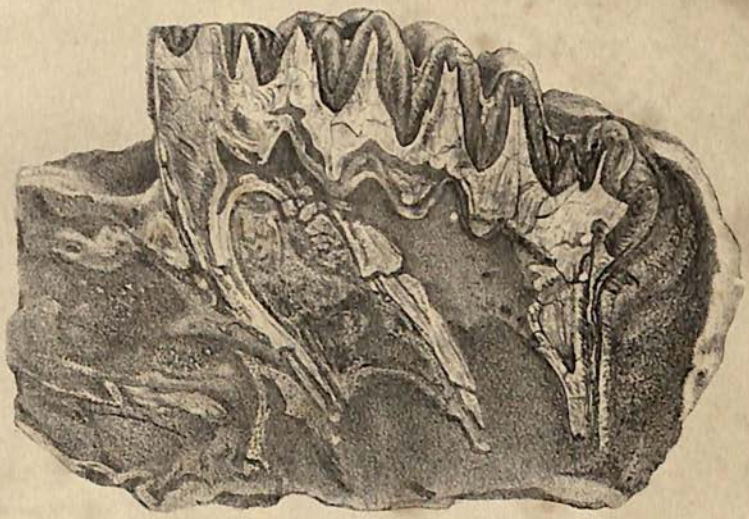


Fig. 2.

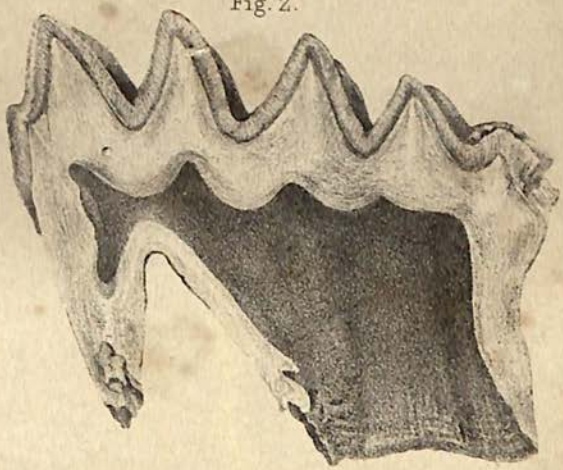
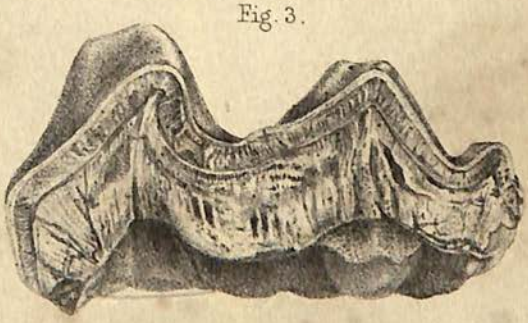


Fig. 3.



G.H.Ford del. J.Dinkel lith. W.West imp.

1. Mastodon Sivalensis. 2. M. Ohioticus. 3. Dinotherium giganteum.

distinct section, agreeing in having the three molars which precede the last, viz. the third deciduous molar and the penultimate and antepenultimate true molars, uniformly characterized by having their crown divided into *three* ridges in both jaws; while the same teeth in the preceding group have each a crown with *four* ridges. The teeth of *M. Andium* and *M. angustidens* are not included in the plates of sections. Following the same serial arrangement which has been observed throughout, their place would be between *M. Sivalensis* and *M. Ohioticus*, the latter of which forms the terminal link in the chain, establishing the nearest passage into *Dinotherium*, and through that genus into the ordinary Pachydermata.

Fig. 3 of Pl. VI. and fig. 3 of Pl. VII. (Pl. III. figs. 11 and 12, F.A.S.), represent sections of the penultimate lower molar of two species of *Dinotherium*, the former a fragment, showing the posterior half of the tooth in *D. Indicum*, and the latter the whole tooth in *D. giganteum*. The sections exhibit the same arrangement of the dental substances as in *M. Ohioticus*. The tooth, Pl. VII. fig. 3, consists of two transverse crenulated ridges, and a talon ridge, while in the equivalent molar of *M. Ohioticus* there are three principal ridges. Corresponding to the smaller number of divisions, the ridges in *D. giganteum* are more widely separated, less elevated, and broader at their base, while the interspaces are also wider and more open than in the North American mastodon; the layer of enamel is of similar thickness, and there is no appreciable crust of cement. The correspondence is followed out in the form of the subordinate heel ridge. *D. Indicum* is the species which is most nearly allied to *M. Ohioticus*; and all the ascertained evidence regarding it tends to prove that it belonged to a true Proboscidean Pachydermatous genus like the latter.

§ 3. On the Succession of the Molars, and their Characters as indicating Sectional Groups of Species.

The molar teeth, developed during the course of life in the ordinary Pachydermata, are divisible into three well-marked sets; the milk or deciduous molars, the false molars or successional premolars, and lastly, the true molars. The milk teeth are so distinct, in their transitory character, from the permanent series, that the consideration of the former is usually omitted in the construction of generic definitions; but in *Mastodon* and *Elephas*, the succession of the teeth is so modified, and the premolars are so completely or partially suppressed, that the triple division is rendered very obscure, and it has commonly been found necessary by systematic authors, to

include the whole series, in framing the expression of the dental formula. In fact, till the appearance of Professor Owen's 'Odontography,' the normal division and theoretical signification of the different molar teeth in these genera were not understood.[1]

In the ordinary Pachydermata, which the rhinoceros may be supposed to represent, there are normally four milk or deciduous molars in both jaws, the hindmost of which has the complicated form which characterizes the last true molar of the adult animal. They are frequently reduced to three in other genera, by the suppression of the anterior tooth, which is the most variable and rudimentary in form. These teeth are succeeded vertically by an equal number of premolars, the last of which is always of a simpler form than the tooth of which it takes the place; and they, in like manner, are subject to a numerical reduction by the non-development of one or more of the anterior teeth. Behind the premolars are the true molars, the normal and developed number of which is invariably three, this set being exempt from the partial suppression to which the others are subject. They are distinguished from the premolars by greater complexity of form; they come into place like the milk molars, in antero-posterior succession, and the first of the series is protruded and in use before the appearance of the last premolar, which immediately precedes it in position in the jaw. In the adult animal, in most genera, the whole of the premolars and true molars are simultaneously present and in use in the jaws. A remarkable exception from this rule takes place in the subgenus of the hog tribe, called *Phacochœrus*, in which, in consequence of the complicated form and large size of last true molars, there is not room in the jaws to accommodate the whole number at one time, and the first true molar is worn down and pressed out before the last molar is protruded. This last molar is gradually pushed forward, causing the anterior teeth to be shed, so that the number of molar teeth in the upper jaw, which at one time in the adolescent animal amounts to five on each side, is finally reduced to one or two in the advanced age.[2] Precisely analogous conditions take place in the true elephants, in which this kind of exception from the ordinary mode of dental succession is carried to the greatest known excess.

Dinotherium.—The first and most simple deviation from the usual Pachydermatous type, in the dentition of the Proboscidea, is presented by *Dinotherium*. In this genus only two milk molars, viz. the penultimate and last, have been

[1] *Ante*, p. 51.

[2] Owen, Odontography, p. 550.

met with in both jaws, one or two of the anterior teeth of this set being suppressed. The last milk molar, above and below, is three-ridged, while the penultimate has only two ridges. These teeth are replaced vertically by an equal number of premolars, which represent the penultimate and last, the two anterior teeth of this series being also suppressed. The last premolar, as well as the penultimate, is only two-ridged, conforming to the ordinary rule of being simpler in form than the milk molar which it succeeds. Of the three true molars, the first or antepenultimate, in both jaws, is three-ridged, repeating the complex form of the last milk molar, while the penultimate and last are only two-ridged. This is a very remarkable anomaly, of which no other example is known among the Pachydermata, as it is commonly the last true molar which reiterates the form of the last milk molar. The first true molar is protruded and in use before the last molar is shed, so that in the adolescent animal there are two contiguous teeth, which have each three ridges. We have, in this circumstance, the first essential proboscidean character, which at once distinguishes *Dinotherium* from the Tapirs and allied genera, and indicates its near relations to *Mastodon*.

In regard to the number of teeth which are in place and in use at the same time, *Dinotherium* is less aberrant than even *Phacochœrus*, as the two premolars and three true molars in the adult animal are simultaneously present in both jaws. The molar formula in *Dinotherium* is therefore 2 premol. + 3 mol. = 5 in each side of both jaws; and the number of ridges in the different teeth, according to their successive position in the jaw, is 2 + 3 in the milk molars; 2 + 2 in the premolars, and 3 + 2 + 2 in the true molars.

Mastodon. Sect. Trilophodon.—*M. Ohioticus.*—The next degree of deviation from the ordinary dental rule is presented by *Mastodon Ohioticus*. In this species, which appears to be the most nearly allied of the well-known forms to *Dinotherium*, there are three deciduous molars in both jaws, the most anterior of the series being suppressed. Of these, the antepenultimate, or anterior tooth (being theoretically the second), in the upper jaw, measures 1·4 inches in length, by about 1·4 in width; and the penultimate, or second (theoretically the third), measures 1·7 by 1·75 inches. These teeth are of the same form, each consisting of four points, which are disposed in two transverse ridges; and they further correspond with the same teeth in the ordinary Pachydermata by differing but slightly in relative size. The third milk molar, as in *Dinotherium*, consists of three transverse ridges, each composed of two pairs of confluent points. It measures three inches in length, by 2·4 in width. The milk molars of the

lower jaw differ in no important respect from those of the upper, except in being narrower in proportion to their length, and in the greater development of the anterior and posterior subordinate talon ridges.

With respect to the premolars, the statements which have been advanced regarding them are conflicting. They have never been observed in either of the jaws by Godman, Hays, Cooper, Harlan, or any other of the American naturalists who have described the dentition of *M. Ohioticus*; nor has their presence been noticed by Dr. Grant. But Professor Owen, in his 'British Fossil Mammalia,' affirms that they have been recognized in this species; and in his 'Odontography,'[1] he figures and describes a tooth as the penultimate premolar of the upper jaw. It is there stated to be composed of two bifid transverse ridges, girt by a basal cingulum, and to be of a simpler form than the second deciduous molar; the crown being broader in proportion to its length, and measuring one inch five lines, by one inch four lines.

Professor Owen also gives a figure of the hypothetical position of the same tooth in the lower jaw,[2] the presence of which he admits has not yet been established in the species. The accurate determination of this point is of considerable systematic importance, as the occurrence of this premolar constitutes one of the two characters upon which (failing those advanced by Cuvier) Professor Owen founds his generic distinction between *Mastodon* and *Elephas*. Had the tooth been observed *in situ* in the jaw, as in the Dax Specimen of *M. angustidens* figured by Cuvier, and in the specimens of *M. longirostris* figured by Kaup, its occasional presence in the upper jaw of *M. Ohioticus* would have been placed beyond doubt; but the tooth described by Professor Owen appears to have been a detached specimen, and no characters are attributed to it inconsistent with its being the first milk molar of the upper jaw. In order to arrive at a certain determination of the point, we have been permitted to make a section of a specimen consisting of the entire palate of a young *Mastodon Ohioticus* in the British Museum, containing the second and third milk molars, with the first true molar protruded and the second true molar in germ. A section was made both along the palate, and along the outside of the jaw; but not a trace of a premolar was visible, although the cranium was exactly of the age when a premolar, if developed, ought to have been shown. A similar negative result attended a corresponding section of a specimen of the same age of the lower jaw. The only other evidence which

[1] *Loc. cit.* p. 260. Pl. 144, fig. 3, *p.* 1.

[2] *Ibid.* Pl. 144, fig. 7, *p.* 1.

could establish the case would be the finding of an unknown tooth in front of the third milk molar. But, so far as we are aware, no instance of this sort has been recorded, notwithstanding the great number of young specimens which have been described by different observers; and the result of the whole evidence at present is, that, ordinarily, the premolars are entirely suppressed in *M. Ohioticus*, in both jaws.

There is nothing, therefore, in the mode of succession of the teeth in this species, to show where the deciduous series terminates and the true molars begin. The last milk molar is followed in antero-posterior succession, as in *Dinotherium*, by a tooth which has its crown divided also into three ridges, and is thus indicated to be the antepenultimate, or first true molar. It measures four inches long, by about three in width, differing only in size from the tooth which precedes it. The penultimate, or second true molar (being the fifth in the order of succession), consists also of three ridges, and measures about five inches by three and a half. The third, or last true molar, consists of four principal ridges, and a small heel ridge, which varies considerably in amount of development. This tooth measures 7·25 inches or upwards, by about 4·5 in width.

The inferior true molars in *M. Ohioticus*, agree with the upper in the form and division of their crowns, except the last, which has usually five principal ridges. They are narrower in proportion to their length, and the subordinate talon ridges are more developed. The molar formula in this species is, therefore, 3 milk molars in the young animal; and 0 premol. + 3 true molars = 3 in each side of both jaws of the adult; the number of ridges in the different teeth, according to their succession, being $\frac{2+2+3}{2+2+3}$ in the milk molars, and $\frac{3+3+4}{3+3+5}$ in the true molars. With regard to the number of teeth which are simultaneously present in the jaw; the lower jaw of *Tetracaulodon* figured by Godman,[1] shows the three milk molars in use, and the first true molar in its alveolus, there being four out of the whole number of six teeth at one time in the jaw. These are ultimately in advanced age reduced to the last tooth, the others being shed.

M. angustidens.—The dentition of *M. angustidens* is involved in great confusion, in consequence of most authors who have written on this species having mixed up, under this name, two distinct forms, the one characterized like *M. Ohioticus*, by a *ternary*, the other, by a *quaternary* division, in the ridges of the middle teeth. It will be necessary to

[1] Amer. Phil. Trans. New Series, vol. iii. pl. xviii.

enter at some length upon the evidence on this point, more especially, as the two latest authorities of weight, Prof. Owen and M. de Blainville, do not admit a specific difference between *M. angustidens* and *M. longirostris*. On the other hand, Dr. Kaup has, in some instances (as in the case of the Stellenhoff lower jaw found near Vienna[1]) excluded from his *M. longirostris*, specimens which assuredly belong to it; while in others (viz. the Georgensmünd mastodon teeth described by von Meyer) he has transferred to this species molars which appear to pertain to *M. angustidens*.

The first point to determine, under these circumstances, is the form to which the specific name of *M. angustidens* is properly applicable. Cuvier's description of the species commences with the Simorre tooth[2] which has the crown divided into three ridges, with a back talon of two tubercles, measuring 4·5 inches in length by 2·35 in width. The next specimen which he describes as belonging to it is the Dax fragment (Oss. Foss. Pl. III: fig. 2) containing two teeth implanted in the palate on one side, the anterior of which is the unworn germ of a premolar, and the posterior, nearly of the same size as the Simorre tooth, like it consists of three ridges and a small talon of two tubercles. A third tooth which he immediately afterwards attributes to this species, is another Simorre specimen (Oss. Foss. Pl. III. fig. 3) measuring 3·6 inches by 2·6, and having its crown also divided into three ridges. It is therefore to a species having the intermediate molars distinguished by a ternary division of the crown, as in *M. Ohioticus*, that the specific name of *M. angustidens* is strictly applicable, so far as priority of description and reference to original types can be taken as the guides to a decision on the point.

Of the other specimens referred by Cuvier to his *M. angustidens*, and represented in the four plates devoted to 'Divers Mastodontes,' the South American teeth (figs. 6 and 7 of Pl. I. and fig. 4 of Pl. III.) appear to belong to *M. Andium*, as has been advanced by M. de Blainville, and nearly all the rest, which are susceptible of determination, belong to *M. Arvernensis* (M. longirostris of Kaup), with the exception of figs. 1 and 2 of Pl. I., fig. 11 of Pl. II., and fig. 14 of Pl. III., which are probably to be referred to *M. angustidens*.

We have already stated the grounds[3] upon which Von Meyer, following up the observations of Croizet and Jobert, distinguished *M. Arvernensis* from *M. angustidens*, and that Kaup was led by his researches to the same conclusion. It would appear, from a communication in Bronn's 'Lethæa,' that the ridge formula which Kaup attributed with doubt to *M. angus-*

[1] Cuv. Oss. Foss. edit. 1834, tom. ii. p. 363, pl. ii. figs. 4 and 5.

[2] Oss. Fossil. tom. i. p. 255; Divers Mastodontes, pl. i. fig. 4.

[3] *Ante*, p. 60.

tidens is $\frac{2+?+3?}{?+3+3}$ in the deciduous series, and $\frac{3?+4+5}{3?+4+4}$ in the true molars.[1]

M. de Blainville has entered at great length, in his 'Ostéographie,' on what had been previously written regarding *M. angustidens*, and he has given a beautiful series of illustrations of all the teeth in succession, in both jaws, as he conceives them to be developed in this species. The rich collection of specimens, discovered by M. Lartet and others in Gascony and along the flanks of the Pyrenees (a large portion of which is displayed in the palæontological gallery of the Paris Museum), furnishes ample materials for establishing the specific independence of *M. angustidens* and *M. longirostris*. But M. de Blainville has not attached sufficient importance to the constancy of the ridge formula; he has throughout his illustrations intercalated Eppelsheim teeth of the latter species, having four ridges, with Gascon specimens of the former, having three ridges. In consequence, the teeth of the two species are not merely intermixed, but a wrong position in the jaw is in many instances assigned to M. Lartet's specimens of the true *M. angustidens*. This remark applies, without exception, to the determinations of the two last teeth of the upper jaw. Giving a numerical expression to M. de Blainville's descriptions of the different teeth, the ridge formula in *M. angustidens* would be $\frac{2+3+4}{2+2+3}$, $\frac{3+4+5}{3+4+6}$, respectively, in the three deciduous and three true molars on each side of both jaws. It is apparent that the lower numbers do not coincide with the upper, and that, followed in sequence, they deviate widely from the uniform succession of three ridges presented by the last deciduous, and the first and second true molars, in *M. Ohioticus*.

Professor Owen has on two occasions described in detail the dentition of *M. angustidens*, and the result stated in his 'Odontography' is, that he has seen as yet no evidence that the teeth described by Cuvier and by Kaup characterize different species. In his 'British Fossil Mammalia' he identifies English specimens with some of the typical forms figured by Cuvier, and the number of ridges which he assigns to the different teeth, according to their succession, is 2+3+3 to the deciduous molars, 2 to the small premolar, and 3+4+5 to the true molars.[2] This formula is liable to the same objections as that put forward by M. de Blainville. In his 'Odontography,' however, published subsequently, Professor Owen describes the teeth of *M. angustidens* in a different manner, and the number of ridges assigned by him to the

[1] Lethæa Geognost. p. 1239.

[2] British Fos. Mam. p. 286.

successive molars in the upper and lower jaws may be expressed thus: $\frac{2+3+4}{2+3+4}$ in the deciduous molars, and $\frac{4+4+5}{4+4+5}$ in the true molars.[1] This formula, with the exception of the number attributed to the last milk molar of the lower jaw, is precisely the same as that assigned by Dr. Kaup to his *M. longirostris*, Professor Owen having referred, in almost every instance on this occasion, to Kaup's figures, which he quotes as the types of his descriptions. But he still alludes to Cuvier's Dax specimen of *M. angustidens* as identical with Kaup's species, although it is represented in the original figure, and described by Cuvier, as three-ridged; and he states, in the 'British Fossil Mammalia,' that the rich series of analogical facts in the dentition of *M. giganteus* (*M. Ohioticus*), would 'now appear to complete the demonstration of the specific identity of the *Mastodon longirostris*, and *Mastodon angustidens*.'[2]

From these details it will be seen how various and opposed the opinions of the best authorities are, up to the present time, regarding *Mastodon angustidens*. In consequence of its rarer occurrence in the fossil state, the available materials for tracing the dentition of this species are less numerous and complete than in the case of *M. Ohioticus*. The following descriptions are chiefly derived from specimens in the Paris Museum, the most of which have been figured by M. de Blainville.[3] Of the milk or deciduous molars in the upper jaw, the third only has yet been met with *in situ* in the palate. It is well shown, on the right side, in the posterior tooth of the Dax specimen figured by Cuvier[4] and referred to above, the crown consisting of three transverse ridges, and an accessory talon of two tubercles, each of the ridges being composed of two pairs of confluent mammillæ. A single tubercle juts out into each of the hollows between the ridges alternately with the principal points, causing the trefoil-shaped discs, which the worn teeth present in this species, so different from the lozenge-shaped discs of *M. Ohioticus*. The dimensions of this tooth are not mentioned by Cuvier, but it may be gathered from the context of his description that it measured a little above three inches long by about two in width. The same tooth, of the left side of the upper jaw, is seen in a most instructive specimen found by M. Lartet, near Sansans, in the department of Gers, containing two molars *in situ*, both of which are three-ridged. Of these the anterior,

[1] Odontography, pp. 619–23.

[2] British Fos. Mam. p. 290.

[3] During a visit to Paris, I had the freest access to these specimens, by the liberal permission of MM. de Blainville and Laurillard.—[H. F.]

[4] Oss. Foss. pl. iii. fig. 2.

which is the third milk molar corresponding with the Dax tooth, is in an advanced stage of wear, the ridges of the crown being ground down into three disc surfaces. No back talon is distinguishable; if originally present, it has merged into the wear of the last ridge. This tooth measures 3·15 inches long, by 2 of width in front, and 1·75 behind, narrowing a little towards the posterior end. It is figured by M. de Blainville.[1] The same collection possesses another detached specimen from M. Lartet, of exactly the same size, but less worn, which shows three distinct ridges and a small subordinate talon. The grinder described and figured by Von Meyer, in his memoir on the fossil remains of Georgensmünd,[2] appears to furnish another example of the third milk molar of the upper jaw, left side, of this species. The crown is divided into three ridges, with a small posterior talon. It corresponds closely to the Gers specimens in dimensions, being three inches long by two in width. Von Meyer describes this tooth as the second milk molar of *M. angustidens*, but the size would seem to be conclusive against the correctness of this determination. Kaup compares it to the third upper molar of his *M. longirostris*.[3]

With regard to the first and second upper milk molars, neither of these teeth having yet been observed *in situ* in the jaw, we are unable to refer with confidence to any specimens for their characters. But we are inclined to regard the tooth described by Von Meyer[4] (Pl. I. fig. 4) as representing the penultimate, or second, and fig. 2 of the same plate as the first. The former measures 2·2 inches by 1·4, and is composed of three ridges, which are so far advanced in wear as to furnish no good diagnostic characters. Von Meyer refers it with doubt to the last milk molar of the lower jaw, while Kaup considers it to be the second upper of the left side of his *M. longirostris*.[5] The specimen[6] here regarded as the antepenultimate, or first milk molar, has a square crown composed of four points. It measures 1·6 inches in length by 1·4 in width, resembling closely in form and dimensions the small Simorre specimen figured by Cuvier,[7] which is also about 1·6 inches long by 1·4 wide, and is regarded by M. de Blainville as the first upper molar of *M. angustidens*. This eminent palæontologist assigns the same place to several other specimens from M. Lartet and others; but such of these figures as are susceptible of exact determination, from their being found *in situ* in the jaw, are derived from Auvergne and Eppel-

[1] Ostéographie, pl. xv. fig. 3 *c* sup.
[2] P. 38, tab. ii. fig. 7.
[3] Oss. Foss. de Darmst. p. 81.
[4] Georgens. p. 38, tab. i. fig. 4.
[5] Oss. Foss. de Darmst. pt. iv. p. 73.
[6] Fig. 2 of Von Meyer's plate.
[7] Diver. Mast. pl. i. fig. 2.

sheim specimens of *M. longirostris*. The same remark applies to M. de Blainville's figures and descriptions of the second milk molar in both jaws.

Of the inferior milk molars, the two anterior, like the upper, have not yet been found *in situ*, and the specimens which have been assigned to them are, in consequence, in a great measure conjectural determinations. The first was probably a simple tooth consisting of a pair of cusps; and the second, reasoning from the analogy of the same tooth in the nearly-allied *M. Andium*, was probably three-ridged. The third is represented by the 'dent de Saxe,'[1] upon which Cuvier founded his nominal species of *M. minutus*, but which M. de Blainville with reason attributes to *M. angustidens*. It is of the left side of the lower jaw; the crown is divided into three ridges, each composed of two pairs of confluent points, with a well-developed back talon of two tubercles, and one or two subordinate tubercles in the spaces between the ridges. The dimensions of this specimen are 3·25 inches long, by 1·25 of width in front, and 1·65 behind. An unworn germ, of unknown origin, in the British Museum, of the same size as the Saxon tooth, and exactly resembling it in the ternary division and form of the crown ridges, furnishes another example of the third inferior molar. M. de Blainville[2] attributes the same place to a worn three-ridged tooth, from the collection of M. Lartet, found near Sansans.

We have seen that the premolars, of which two are developed in *Dinotherium*, appear to be entirely suppressed in *M. Ohioticus*. But there is no doubt about the presence of one in the upper jaw of *M. angustidens*. A beautiful illustration of this tooth is furnished by the Dax specimen, previously referred to. As figured in the 'Ossemens Fossiles,'[3] it is shown as a germ of a square form and composed of four points. It is proved to be a premolar, and to be protruded vertically in the ordinary manner, by being unworn, while the third milk molar behind it has the three ridges well affected by wear. This circumstance is clearly indicated by Cuvier in his description of the specimen.[4] Von Meyer refers to the same tooth the Georgensmünd specimen represented in tab. 1, fig. 1, of his Memoir, which resembles the Dax specimen in form, and in the crown being composed of four points; it measures about 1·6 inches square. This upper premolar, as has been pointed out by Professor Owen, takes the place of the second milk molar; it therefore represents the penultimate of this series. There is no evidence that the

[1] Oss. Foss. pl. ii. fig. 11.
[2] *Loc. cit.* pl. xv. fig. 3 *b*.
[3] Pl. iii. fig. 2 *a*, *b*.
[4] Ossemens Fossiles, tom. i. p. 256.

third milk molar of the upper jaw in this species is followed by a corresponding vertical successor. It is of importance to observe this apparent irregularity in the order of suppression. In *Dinotherium* the two last premolars are developed, the two anterior being suppressed; in *M. Ohioticus* the whole four remain undeveloped; while in *M. angustidens* the penultimate alone is developed, the two anterior and the last being suppressed. A similar order of suppression has been observed in the premolars of *M. longirostris*.

In regard to the lower jaw, there is no evidence yet that a premolar is included in the dental succession of the inferior grinders. Von Meyer, with doubt, assigns this place to a detached tooth which he figures,[1] but the determination is merely conjectural, Kaup referring it to his *M. longirostris*; and it is by no means certain that this specimen does not belong to the upper, rather than to the lower jaw. That a rudimentary lower premolar may have been developed in this species is highly probable; but we are not warranted, in the absence of direct proof, to hazard any inference respecting organs which are liable to be entirely suppressed, and which, when developed, are so rudimentary in form as not to be of functional importance in this tribe of animals.

The materials to illustrate the dentition of the adult animal have been found in sufficient abundance to leave no room for doubt respecting the characters and succession of the true molars. The antepenultimate, or first,[2] is seen in the Sansans specimen from M. Lartet, *in situ* in the left side of the upper jaw, along with the third milk molar which we have described. It is an oblong tooth, in the condition of an almost unworn germ, having the crown divided into three distinct ridges, with a well-marked basal cingulum on the inside, and a small back talon. It measures 4·13 inches in length by 2·75 of width in front, and 2·75 behind.

Another example of this tooth appears to be furnished by fig. 5, of tab. 1, of Von Meyer's memoir. The crown has the same three-ridged form as the Sansans specimen, with which it agrees very closely in dimensions, being 4·2 inches long by 2·7 in width. Von Meyer refers it with doubt to the third molar of the lower jaw, right side of this species, while Kaup assigns to it the same position in the lower jaw of his *M. longirostris*.[3]

The penultimate, or second true molar, is shown *in situ* along with the last, in another instructive Gascon specimen from M. Lartet, displayed in the Paris Museum. This fragment, likewise, is of the left side of the upper jaw. Of the

[1] *Loc. cit.* tab. i. fig. 2.
[2] De Blainville, Ostéographie, pl. xv. fig. 4.
[3] *Loc. cit.* p. 81.

two teeth which it contains, the anterior (or penultimate) had been a long time in use, and is very much worn. It is nearly rectangular in form, and the crown is distinctly divided into three discs, which indicate the same number of ridges. No back 'talon' is distinguishable, the abrasion of the last ridge being far advanced. The dimensions of this tooth are 4·5 inches long by 2·75 of width in front, and 2·6 behind. It is described by M. de Blainville as the fourth, or antepenultimate.[1] The posterior tooth in this specimen, being the third, or last true molar, like its equivalent in *M. Ohioticus*, is more complicated in form than the two which immediately precede it. The crown consists of four ridges, each composed of two pairs of confluent points, arranged somewhat alternately, and there is no distinct heel ridge appended to the posterior extremity. This tooth is wide in front, and contracts very considerably backwards, a character common in most species of mastodon, to the last molar of the upper jaw. The dimensions are—length, 6·25 inches; width in front, 3·25; width behind, 2·25. The palæontological gallery of the Paris Museum contains numerous other specimens of the last upper molar of *M. angustidens*, four of which, from different localites, have been admirably figured[2] in the 'Ostéographie.' They all agree in having the crown invariably divided into four ridges; the only variety which they present being in the greater or less development of the 'talon' appendage of the last ridge. Of these, the superb Tournans specimen,[3] which comprises[4] the palate with one tooth on each side, and the greater part of the lower jaw, shows a third upper true molar, which resembles very closely the one described above. It is entire; of the four ridges the two anterior are worn, and the two posterior intact. This tooth measures 6·25 in length by 3·25 of width in front, and 2·5 behind, dimensions which are almost identical with those yielded by the other specimen. M. de Blainville describes all these teeth as 'penultimates;' and he adds, 'Il est très singulier, que dans la grande quantité de dents d'*E. angustidens* que M. Lartet a envoyées au Muséum il n'y a pas une seule sixième d'en haut.'[5] But, in our view, the teeth, which are figured and described in the 'Ostéographie,' as representing the 'fifth,' do, in reality belong to the 'sixth' of antero-posterior succession in this species, M. de Blainville's idea of the sixth or last upper grinder, in *M. angustidens*, being derived from a tooth of more complicated form in another species.

[1] De Blainville, *loc. cit.* p. 296, pl. xv. fig. 4 *b* sup.
[2] *Ibid.* fig. 5 *a*, *b*, *c*, *d*, sup.
[3] *Ibid.* pl. xiv.
[4] Here terminates the portion of letter-press already published.—[Ed.]
[5] P. 298.

In the lower jaw, the first, or antepenultimate true molar (being the fourth in the order of antero-posterior succession), like the milk molar which precedes it in position, has a crown composed of three ridges, with a hind talon of two tubercles. In a detached Gers specimen from M. Lartet, which is considerably advanced in wear, it measures 4 inches in length, by 2 of width in front, and 2·4 behind. It differs from the corresponding tooth of the upper jaw chiefly in the talon, and in being broader behind than in front; the reverse of which takes place in the upper. This dilatation of the posterior part is very constant in all the lower molars of *M. angustidens* except the last. M. de Blainville refers to this character in describing the third lower molar in this species as being somewhat 'en forme de gourde.'[1]

The second, or penultimate, occurs *in situ* along with the third in the fine lower jaw figured by M. de Blainville,[2] belonging to the Tournans cranial specimen previously referred to. The penultimate on both sides, in this case, is very much advanced in wear, the ridges being abraded down to the common base of ivory, so that the discs are partly confluent; but the division of the crown into three segments is distinguishable. This tooth on the left side measures 4 inches long by 2·5 in width. Another example of the same tooth is presented by a fine Gers fragment from M. Lartet, comprising the anterior part of the left half of the lower jaw of an adult individual. It is well advanced in wear, but the discs of the crown afford distinct evidence of a division into three ridges. There is an ill-defined basal collar along the outside of the two posterior ridges, which sweeps around the last so as to form a small terminal talon. This tooth is considerably broader behind than in front, the dimensions being—length, 4·5 in.; width in front, 2·25, and behind, 2·63 inches. This specimen corresponds very closely in size, age, mineral condition, and external character generally, with the palate specimen, also from M. Lartet, which furnished the first illustration of the last molar, along with the penultimate of the upper jaw; and it is not improbable that they may have been derived from the same individual. Several other examples might be quoted in proof of the constancy of the ternary division of the crown, and of the relative proportions in this tooth. Among these is the Simorre specimen figured by Cuvier,[3] which is composed of three ridges and a talon of two tubercles; the dimensions being—length, 4·5; width in front, 2·; and behind, 2·55 inches.

[1] P. 299.

[2] Ostéographie, pl. xiv. and xv.

[3] Oss. Foss. tab. i. fig. 4.

Another example is furnished by a beautiful specimen of unknown origin, in the British Museum, which consists of three ridges and a talon appendage of two tubercles. The two anterior ridges are slightly affected by wear, the last being intact. One intermediate tubercle is developed in each of the hollows alternately with the points of the outer division. This specimen belongs to the left side of the lower jaw; it presents the characteristic 'gourd-shaped' expansion at the posterior extremity, and the dimensions correspond exactly with those yielded by Lartet's Gers specimen—viz., length, 4·5; width in front, 2·1; and behind, 2·6 inches.

The third, or last, inferior true molar (being the sixth in antero-posterior succession) occurs along with the penultimate in the Tournans lower jaw specimen already referred to.[1] The crown is divided into four ridges, with a large talon forming a fifth and terminal ridge. The tooth is entire, and the animal to which it belonged must have been aged, as the three anterior ridges are well worn. The plane of the grinding surface shows a considerable amount of concavity from back to front, and the crown narrows very much towards its posterior end, being the reverse of what is seen in the two molars which precede it in position. The dimensions of this tooth are—length, 7·25; and width in front, 3 inches. It is figured by M. de Blainville, and enumerated in the references as the fifth, or penultimate; but it is described by him as the sixth, or last, in the text devoted to the dentition of *M. angustidens*, although the corresponding last tooth of the upper jaw of the same specimen, and which, in fact, was opposed to it in use, is described as the 'fifth.'[2] The occurrence of this last inferior molar *in situ* behind the penultimate, taken in conjunction with the form and dimensions, furnish conclusive proofs that this tooth is the third true molar of the lower jaw; and the evidence yielded by the division of the crown ridges is equally demonstrative that the species from which it was derived is distinct from the *M. longirostris* of Eppelsheim, a conclusion which is further supported by the enormous elongation of the beak of the symphysis in the lower jaw of *M. angustidens*.

The dental formula of the molars in *M. angustidens* appears, therefore, to have been $\frac{1+1+1}{1+1+1}$ milk molars; $\frac{0+1+0}{0+?+0}$ premolars; and $\frac{1+1+1}{1+1+1}$ true molars; and the number of ridges in the different teeth, according to their succession, $\frac{2+3?+3}{2+3?+3}$

[1] De Blainville, Ostéographie, pl. xiv. and pl. xv.

[2] *Idem, loc. cit.* p. 302.

in the milk molars; 2 in the premolars; and $\frac{3+3+4}{3+3+5}$ in the true molars. Omitting the consideration of the two anterior milk molars, which are only conjecturally fixed, and of the premolar, the ridge formula furnished by the four last teeth is exactly similar to that of *M. Ohioticus*—viz., 3 in the last milk molar, and 3 + 3 + 4 in the true molars.

We have deemed it necessary to go so much into detail on this point, as the definition of the ridge formula constitutes the basis upon which the species of *Mastodon* are arranged in this work; and the position could not have been considered as established till the exception presented by the teeth of *M. angustidens*, as ordinarily described, was explained.

M. Andium.—This species, as defined by De Blainville, includes the teeth, upon which Cuvier founded his '*Mastodonte des Cordilières*' and '*Mastodonte Humboldien*,' besides some South American specimens which the great anatomist erroneously identified with the European *M. angustidens*. It is closely allied to the latter species, and there are fortunately sufficient materials available to establish the succession and character of the principal teeth. We shall first describe the grinders of the lower jaw, of which the specimens are most complete.

Among the fine collection of remains of this species from Buenos Ayres, lately acquired by purchase for the British Museum, there is a beautiful specimen of the left half of the lower jaw, broken only at the symphysis and coronoid process, of a young *M. Andium*, corresponding in relative size, and in the development of the teeth, with a sucking Indian elephant of about two years old. (See Plate VIII. fig. 1, copied from Plate XL. fig. 13, F.A.S.) It contains the second and third milk molars *in situ* (the first being broken off), together with the empty alveolar cavity, in which the pulp nucleus of the undeveloped first true molar was lodged. The second milk grinder is fully protruded, but had barely come into use, the two front ridges being but slightly abraded; the third is in the state of an intact germ, and, although fully formed, had not penetrated the gum when the animal died. These teeth are both three-ridged, with a subordinate crest in front and a small bitubercular talon behind. They are exactly alike in form, narrow in front but broader backwards. The ridges, as in *M. angustidens*, consist of two pairs of principal points, which, instead of being nearly simple, as in the latter species, are subdivided into a vast number of superficial warty tubercles, which jut into the valleys, forming a bridge or connection between the contiguous ridges, and interrupting the transverse continuity of the valleys. In this respect they bear a greater analogy

with the young teeth of *M. longirostris* than with those of *M. angustidens*. The dimensions of the second milk molar are—length, 2·6 inches, width in front 1·3, behind 1·5; and of the third—length, 3·5 inches, width in front 1·7. *M. Andium*, therefore, differs from *M. Ohioticus*, and diverges more from *Dinotherium* and the ordinary Pachydermata than does that species, by having a more complex crown in the second milk molar. It supports the presumption that the same tooth in *M. angustidens* was also three-ridged. Neither in this specimen, nor in the more advanced one next to be described, is there any indication of an inferior premolar.

The first and second true molars (being the fourth and fifth in the order of succession) are equally well seen in a fine and hitherto undescribed specimen, also of the left half of the lower jaw of an adolescent *M. Andium* from Chili, belonging to the Canterbury Museum (Plate VIII. fig. 2, copied from Plate XL. fig. 15, F.A.S.).[1] This fragment contains both of these teeth *in situ*, with the pit of the fang of the third milk molar, which had dropped out, and the formed alveolus of the last true molar. The anterior tooth is somewhat worn, and consists of three ridges of complex composition which have rubbed down under the process of mastication into deeply notched trefoil-shaped, or occasionally quadrilobed, discs, together with a talon of two points. The posterior (being the penultimate) is intact, and also has its crown composed of three principal ridges, with a hind talon. Both of these teeth are more rectangular in form and relatively broader in front than the same grinders of *M. angustidens*. In this respect, their proportions resemble those of *M. Ohioticus*. The anterior tooth or antepenultimate true molar measures in length 4 inches, width in front 2·45, and behind 2·55. The penultimate is partly concealed in the alveolus; the estimated length is about 5 inches, and the width in front 2·75 inches.

The perfect lower jaw belonging to the nearly entire adult cranium of this species, from Buenos Ayres, now displayed in the British Museum (Pl. VIII. fig. 3, or Pl. XXXV. fig. 3, F.A.S.), completes the evidence regarding the inferior teeth by presenting the two last teeth *in situ*. The anterior of these confirms what is shown by the Canterbury specimen respecting the penultimate. It is in an advanced stage of wear, but exhibits distinctly the discs of three ridges. The crown is nearly rectangular in form, the dimensions being 5·1 inches

[1] My best acknowledgments are due to Alderman Masters, of Canterbury, for enabling me to examine this very valuable specimen with leisure in London, by putting it at my disposal during several months. The excellent public museum in Canterbury, highly creditable to a provincial city, owes its origin and present condition chiefly to the well-directed exertions of Mr. Masters.—[H. F.]

DESCRIPTION OF PLATE VIII.

MASTODON ANDIUM.

Fig. 1. Portion of left side of lower jaw of a young *Mastodon Andium*, containing the second and third milk molars *in situ*, one-third of the natural size, and copied from a drawing by Mr. Ford in Plate XL., fig. 13 *a*, of the Fauna Antiqua Sivalensis. The specimen is in the British Museum, and was obtained from Buenos Ayres. (See page 99.)

Fig. 2. Left half of lower jaw of an adolescent *Mastodon Andium*, containing the first and second true molars, one-third of the natural size, and copied from a drawing by Mr. Ford in Plate XL., fig. 15, of the F. A. S. The specimen belongs to the Canterbury Museum, and was obtained from Chili. (See page 100.)

Fig. 3. Perfect lower jaw of a nearly adult *Mastodon Andium*, containing the second and third true molars *in situ*, one-third of the natural size, and copied from a drawing by Mr. Ford in Plate XXXV. of the F. A. S. The specimen is in the British Museum, and was obtained from Buenos Ayres. (See page 100.)

Fig. 3.

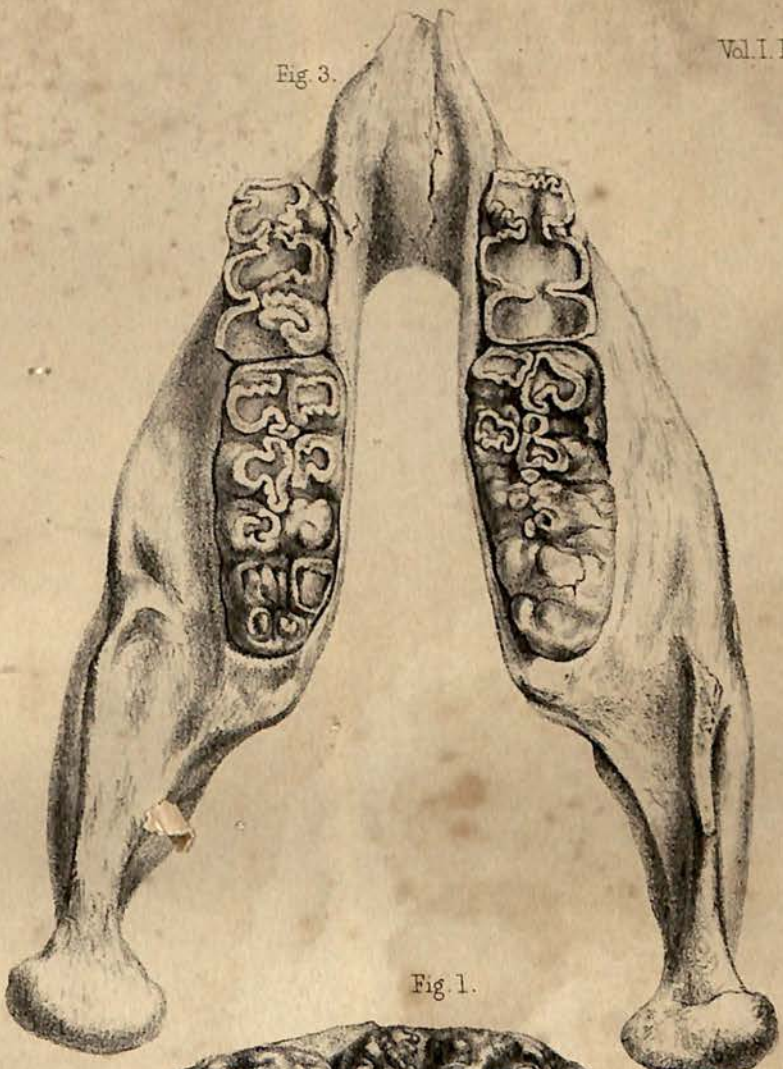
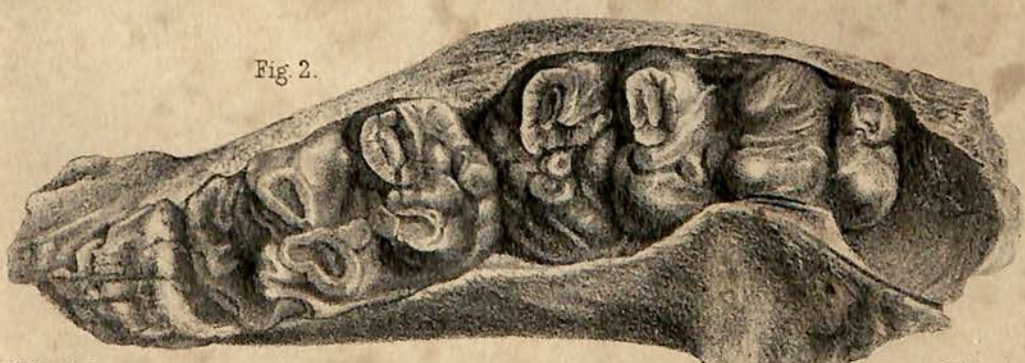


Fig. 1.

Fig. 2.



G.H.Ford del. J.Dinkel lith. W.West imp.

Mastodon Andium.

in length, 2·85 inches of width in front, and 3 inches behind. The posterior tooth, which is the last or third true molar, has the crown composed of four principal ridges, and a convex subtriangular heel of several points. The three anterior ridges are partly worn, and finely exhibit the characteristic complex trefoil discs of wear; the two posterior are intact, and the sinuous hollows between them show the very considerable layer of cement, which, as previously noticed, is present in a greater quantity in this than in any other species of true mastodon. The dimensions of this tooth are about 8 inches in length by 3·5 inches of width in front, whence it narrows gradually towards the posterior end. Another detached specimen in this collection exhibits the same form, and is very nearly of the same size.

These three specimens, each presenting two molars *in situ*, and respectively derived from the very young, the adolescent, and the aged animal, furnish the clearest demonstration regarding the dentition of the lower jaw in *M. Andium*. Additional confirmation is derived from the fine specimen of the lower jaw, containing two entire three-ridged teeth *in situ*, described by M. Laurillard, in M. d'Orbigny's work on South America;[1] and by Gay's specimen from Chili, figured by De Blainville, which consists of the greater part of an adult lower jaw, with the second and third true molars *in situ*, these teeth corresponding in form and dimensions with the penultimate and last molars of the adult lower jaw in the British Museum. The specimen figured by Cuvier[2] appears to be the last molar of the lower jaw.

The materials illustrative of the molar series of the upper jaw in *M. Andium* are less complete; but the uniform correspondence between the four last teeth in the upper and lower jaws of *M. Ohioticus* and *M. angustidens* would, *à priori*, lead to the inference that a similar agreement had held in *M. Andium*. We are not aware of the existence of specimens or figures of the first and second upper milk molars of this species; but we are warranted in inferring that the second was three-ridged, as in the lower jaw. The third deciduous molar is well represented by Cuvier (tab. ii. fig. 5). The original, brought by Humboldt from Chili, is the specimen upon which the illustrious anatomist founded his *M. Humboldtii*. It is an oblong and nearly rectangular tooth, presenting the same square proportions as in *M. Ohioticus*, and having the crown divided into three ridges, which are far advanced in wear, and without either a front or a back talon.

[1] Alcide d'Orbigny, Voyage en Sud Amerique. Palæontologie, pl. x. figs. 1 and 2.

[2] Oss. Foss. tab. iii. fig. 4.

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It measures 3·15 inches in length by 2·35 inches in width. As yet there is no evidence of a premolar in the upper jaw.

Of the true molars, the first or antepenultimate (being the fourth in the order of succession) appears to be represented by fig. 7 of Cuvier's Plate I. of 'Divers Mastodontes.' The anterior part of the first ridge is broken off; the crown consists of three ridges which are far advanced in wear, together with a talon of three tubercles. The dimensions, inferred from the description given by Cuvier, would be about 4·5 inches of length, by 2·6 in width. This specimen was brought by Dombey from Peru; and it is referred by Cuvier to *M. angustidens*. The penultimate, or second true molar, is represented by the Imbaburra specimen discovered by Humboldt, in the volcanic region of Quito, and seen in fig. 1, tab. ii. of the 'Divers Mastodontes.' Like the two preceding molars, it is of a broad rectangular form, having three ridges to the crown. The dimensions stated by Cuvier are, 4·7 by 3·35 inches. The third or last true molar occurs *in situ*, in the cranium belonging to the British Museum, as a solitary tooth on either side, the penultimates having been worn out. The crown is composed of four ridges and a large complex heel. The anterior ridges are well worn, and present deeply notched trefoil discs. This tooth, on the left side, presents the following dimensions, viz. length 3·75 inches, width in front 3·75, and behind, 3·25. Another detached specimen in the same collection, and in nearly the same stage of wear, measures only 6·75 inches in length, by 3·5 in front, and 2·75 behind. It consists also of four ridges and a heel; the sinuous hollows between the ridges display a decomposed layer of cement of considerable thickness. Other examples of this tooth are shown in De Blainville's Ostéographie; and the same position may be assigned to Dombey's specimen from Peru,[1] which exhibits four ridges and a compound double heel. Cuvier refers it to his *M. angustidens*. We have ascertained that the old palate specimen preserved in the British Museum, which is figured and described by Peter Camper,[2] referred by him to *M. Ohioticus*, and by Cuvier to *M. angustidens*, belongs in reality to this species. Camper, in this instance, as in the case of Michaeli's palate fragment of *M. Ohioticus*,[3] took the posterior extremity of the palate for the muzzle end, and he has in consequence described the back tooth as the front one. This specimen, of which the precise origin is unknown, appears to have been presented to the British Museum by the Earl of Shelburne, with specimens of *M. Ohioticus*, sent by Croghan, from North

[1] Oss. Foss. tab. i. fig. 6 of 'Divers Mastodontes.'

[2] Nova Acta Petrop. tom. ii. tab. viii.

[3] *Loc. cit.* tab. ix.

America, some of which have been figured and described by Peter Collinson and William Hunter.[1]

The ridge formula, in the successive molars of *M. Andium*, may therefore be safely expressed as $\frac{(2) + (3) + 3}{(2) + 3 + 3}$ in the milk molars, and $\frac{3 + 3 + 4}{3 + 3 + 4\text{-}5}$ in the true molars, the only difference from *M. Ohioticus* being an additional ridge in the second milk molar. The constancy of the ternary division in the last milk molar and the first and second true molars in both jaws of these species, and of *M. angustidens*, defines a well-marked group of mastodons, for which we propose the sectional name of *Trilophodon*. Of these *M. Ohioticus* was the most colossal form, next *M. Andium*, and last *M. angustidens*, which appears to be the smallest known species among the elephantine Proboscidea. While the first of all the species indicates the nearest affinities to *Dinotherium*, the molar teeth of the two last present close analogies to those of *Hippopotamus*, to gigantic forms of which genus the earlier palæontologists were led to refer them. To the same section *M. Tapiroïdes* appears also to belong, so far as the limited information regarding the dentition of the species will warrant an inference respecting it.

M. Tapiroïdes.—Cuvier founded this nominal species upon a single tooth from Montabusard, near Orleans,[2] the crown of which, divided into three lobes, is not bisected along the axis by a longitudinal furrow, as in *M. angustidens* and the other species, these eminences being continued across, and their edges simply cremulated with small regular denticulations, as in the teeth of *Dinotherium*. It has also a small talon, which exhibits the same cremulated character. This tooth would correspond in size with the second milk molar of *M. Andium*. Regarded *per se*, it does not furnish sufficient evidence to establish a distinct species of *Mastodon*.

Buffon, in 1778, had described two large grinders, the one stated to have been found in Little Tartary, and the other in Siberia, both of which Cuvier referred to *M. Ohioticus*, at the same time that he questioned the accuracy of the localities attributed to them; having restricted the geographical range of this species to the North American continent. Doubts were also expressed by him regarding a three-ridged grinder, figured by Pallas,[3] and described by the latter as belonging to the species of the Ohio, although found in the Ural mountains. In the additions to the last edition of the 'Ossemens Fossiles,' Cuvier relinquished his doubts regarding

[1] Phil. Trans. vol. lvii.
[2] Oss. Foss. p. 267, tab. iii. fig. 6.
[3] Oss. Foss. tom. iii. addit. p. 375.

the occurrence of *M. Ohioticus* as a European species, upon the evidence of an Italian fossil grinder, described by Borson, as having been discovered in the hills of Villanova, near Asti; but the great anatomist throws out a query, whether it might not belong to a distinct species? Since that time similar remains have been discovered in Switzerland, and in different parts of the South of France, which M. de Blainville has brought together and described as a distinct species, under the name proposed by Cuvier, of *M. Tapiroïdes*. Laurillard, in a note appended to the posthumous edition of the 'Ossemens Fossiles,' had previously expressed his opinion that these remains indicated a species different from the North American mastodon, but he has not characterized it by any name.

The whole of the known materials attributed to this species are at present inadequate to show what its dental system really was. The back grinders are those in regard to which there is least doubt. Of these the specimen described by Professor Borson is one of the most characteristic. Like the last upper molar of *M. Ohioticus*, the rectangular crown is composed of four transverse trenchant ridges, which are obscurely divided into two pairs of principal points; but their direction is more oblique than in that species, and they are not distinctly bisected by a longitudinal furrow as in the latter. The two first ridges are worn, the second exhibiting a rhomb-shaped disc like that of the American species, while the two last are intact. The talon is broken off. The hollows between the ridges are transverse, and free from any tubercular processes of enamel. The dimensions are 6·1 inches of length by 3·2 inches of width in front. The enamel is stated by Borson to be two lines in thickness. He considers it to have been a back molar of the upper jaw, while M. de Blainville assigns for it the place of the fifth or penultimate of the lower jaw. Whether upper or lower, the form indicates it to have been the last true molar of the jaw. The large grinder figured by Buffon[1] presents a rectangular crown with four trenchant transverse continuously-edged ridges and a small crenulated heel. It appears to have been the last upper true molar. Another specimen of the same tooth, from Antroy, in the department of the Upper Saone, of nearly similar form, is figured by De Blainville,[2] along with specimens from Alan and Sansans. No well-determined examples of the anterior grinders of this species have yet been recorded. Schintz has described the remains of two kinds of mastodon, from the lignite mines of Ellg and Kœpnach in Zurich. Of these, four grinders are referred to *M. angustidens*; the other

[1] *Loc. cit.* pl. i. and ii. p. 411.

[2] *Loc. cit.* p. 318, pl. xvii. fig. 6 *a*.

teeth are stated to belong to a species different from any of those described by Cuvier, and having only a distant resemblance in form to the teeth of the North American mastodon. The large teeth have always three rows of tubercles, the small two rows. The ridges are transverse and trenchant, and the terminal lobes of the contiguous ridges are reflected in a decurrent crenulated crest. These teeth probably belong to *M. Tapiroïdes*. Similar remains, from Kœffnach, have been described by Meissner, and were known to Cuvier. Von Meyer considers them to indicate a distinct species, for which he has proposed the name of *M. Turicencis*. Cuvier mentions that a portion of a tusk, the ivory of which was invested with a layer of channeled enamel, was found along with the grinders noticed by Schintz from Kœffnach. M. de Blainville has described as the first upper molar of this species the small tooth figured by Kaup;[1] but it was overlooked by this eminent anatomist when he made this determination, that the tooth in question, although drawn detached, occurs *in situ* as a premolar germ, above the second milk molar in the young palate specimen of *M. longirostris*, figured by Kaup in the same plate;[2] it has been described in detail as such by Kaup.[3]

This comprises all that can, at present, be safely adduced respecting the dentition of *M. Tapiroïdes*. The large adult grinders, which the size and form indicate to be the last true molars, being uniformly four-ridged, appear to justify the inference that the last milk molar and the first and second true molars would have been three-ridged, as has been shown to be the constant rule in the three previously described species. This conjecture is further supported by the three-ridged grinders described by Schintz; while the Sansans specimen from M. Lartet, attributed by De Blainville to the third molar (being the third or last of the deciduous series) of this species, is also three-ridged. We therefore refer it provisionally to the *Trilophodon* group. The species cannot well be confounded with any other, except *M. Ohioticus*, from which it is sufficiently distinguished by the form of the crown ridges. It is not improbable that, when better known, *M. Tapiroïdes* will prove to be the species of the genus which is most nearly allied to *Dinotherium*.[4]

M. Australis.—Professor Owen has described, under this provisional name, a fossil grinder brought by Count Strzlecki from Australia. The specimen is an entire tooth, the crown of which 'supports six principal mastoid eminences in three

[1] Oss. Fossil de Darmst. pl. xvi. fig. 3.
[2] *Loc. cit.* pl. xvi. figs. 1 and 1 *a*.
[3] *Loc. cit.* p. 70.
[4] *Subsequent Note by Dr. Falconer.*—'The above inferences arrived at in 1846 were confirmed by M. Lartet's observations published in 1851.'—[Ed.]

transverse pairs,'[1] with a narrow subordinate basal ridge in front, and a quadritubercular talon behind. A pair of small tubercles is placed in each of the valleys, in the long axis, forming a connection between the transverse ridges. The dimensions are stated to be 4 inches 10 lines in length, width behind 2 inches 11 lines, and height of the middle ridge from the base of the crown 2 inches 6 lines. According to Professor Owen, the specimen presents a generic and nearly specific identity with Cuvier's representation of *M. angustidens*, as exhibited in Pl. II. fig. 11, Pl. III. fig. 2, and Pl. I. fig. 4 of the 'Ossemens Fossiles.' He considers that it differs as much from *M. angustidens* as the latter does from *M. Andium*, and from the *M. longirostris* of Kaup in the principal transverse ridges being more compressed anteroposteriorly in proportion to the height, while they taper to sharper summits. The dimensions correspond very nearly with those assigned above to the penultimate of the lower molar of *M. Andium*.

The occurrence in the Australian continent of fossil marsupial types of the large Pachydermata, the dentition of which so closely assimilates that of the latter that *Diprotodon* was in the first instance referred to *Dinotherium*, might raise a question whether the specimen under consideration might not be a marsupial representative of *Mastodon*; but Professor Owen, with good reason, believes it to belong to a true *Mastodon*, founding his opinion upon the complex form of the molar. A question of more weight arises respecting the authenticity of the specimen as really of Australian origin. It was not found *in situ* by the eminent traveller, but procured by him from a native of New Holland, at some distance from the asserted locality. The tooth itself does not furnish characters sufficient to distinguish it from *M. Andium*; and until further evidence is adduced, the specific independence of *M. Australis* and its Australian origin must, under these doubts, remain in abeyance. The almost cosmopolitan range of *Mastodon* makes the presumption more probable of a species of this genus extending to New Holland than perhaps of any other genus among the Pachydermata. The specimen belongs to the *Trilophodon* section of *Mastodons*.

No species of this group has yet been discovered in the fossil state in India.

Mastodon, Section *Tetralophodon*.—The group of species for which we propose this sectional name is defined by characters, in the numerical disposition of the crown ridges

[1] Owen, Ann. of Nat. Hist. vol. xiv. 1844, p. 269.

of the grinders, equally constant with those which have been shown above to hold in the section *Trilophodon*: a quaternary division of the crown being presented by every tooth in which a ternary arrangement occurs in the latter. This section, so far as it is known to us at present, comprises four fossil species, two of which are European and two Indian. The two former have hitherto been confounded together by most authors, as well as with *M. angustidens*. Their accurate discrimination is of great importance, as they appear to belong to faunas of two distinct periods.

M. longirostris.—The materials requisite to illustrate the dentition of this species, thanks to the indefatigable researches of Dr. Kaup in the fossiliferous sand of Eppelsheim, are as complete as in the case of *M. Ohioticus*. The series of teeth is beautifully represented in the 'Ossemens Fossiles de Darmstadt.' There were three deciduous molars in the upper jaw; of these, the antepenultimate or first (theoretically the second) is of an oblong form, broader behind than in front, consisting of two ridges disposed in four points; the dimensions being about 1·2 inches long by 0·9 inches broad. The second or penultimate milk molar is composed of three principal ridges, with an obscure talon crest behind, measuring 2 inches long, by about 1·4 of width in front, and 1·6 inches behind. The third or last milk molar has a crown composed of four transverse ridges, with an accessory crest in front, and a talon ridge behind. A sinuous longitudinal channel bisects the crown, along the axis, into an outer and inner division, as in the North American Mastodon, each division of the ridges presenting a finely lobed or denticulated edge, composed of from four to five minute points. These edges are gradually depressed from either side towards the centre, so that they unite at a very open angle. The anterior crest is given off from the principal point of the inner side of the first ridge; it descends obliquely outwards to the base of the outermost point, and is thence reflected backwards in a basal collar, bounding the inner side of the crown. There is no corresponding collar along the outer side. The valleys are transverse, but their continuity across is somewhat interrupted by small mammillæ near the axis, which form a sort of bridge between the contiguous ridges. These characters are minutely and carefully described by Von Meyer. This tooth measures 2·7 inches long by about two inches broad. For the determination of these teeth we have had access to the original specimen, now in the possession of the Earl of Enniskillen, figured by Kaup (Pl. XX. fig. 2),[1] and to a

[1] Also figured in Fauna Antiqua Sivalensis, Pl. xl. figs. 6 and 6 *a*.—[Ed.]

cast of the Darmstadt specimen, also figured by Kaup (Pl. XVI. fig. 1), but first described by Von Meyer, under the name of *M. Arvernensis*. These specimens—the former belonging to the right and the latter to the left side of the jaw—are very nearly of the same age.[1]

* * * * * * *

We now get out of the true Mastodons, and the numerical definition of the crown ridges of the intermediate molars becomes gradually more and more irregular. Instead of characterizing groups of species, as has been shown to hold good with respect to the ternary and quaternary divisions, the next ascertained numerical increments become distinctive marks of individual species only; and as the cypher increases everything like correspondence between consecutive teeth ceases, the number of ridges augmenting with the age of the tooth, till at last they become indefinite.

The next numerical formula after the ternary and quaternary might be expected to be quinary, in the ridges of the last milk molar and the first and second true molars; *but the number five is not met with in these teeth in any known species.* There is an abrupt transition from four to six, which occurs in *Elephas Cliftii*, the species which, in our view, constitutes the first of the elephants, as distinguished from Mastodon, and establishes the immediate passage between the two.[2]

The accessible materials for illustrating the dentition of this species are limited, at present, to the last milk molar and the three true molars of the upper jaw, and the last molar of the lower. The specimens which furnish these are all derived from the kingdom of Ava. The last milk molar is shown in a palate specimen along with the anterior portion of the first true molar, brought by Colonel Burney from the banks of the Irrawaddi, and presented by him to the British Museum.[3] But the crown is worn down to the common base of enamel, and the number of ridges does not admit of being distinctly made out. The first true molar is beautifully shown in fig. 6 of Plate XXXIX. of Mr. Clift's memoir in the 'Geological Transactions.' It is a very broad rectangular tooth, having the crown divided into six ridges, with a small heel ridge. The ridges are continuously transverse, as in the plates of the true elephants, with no indication of the longitudinal furrow which, in all the true Mastodons, divides the crown along the axis into two halves.[4]

[1] There is a deficiency here in the Manuscript, but further remarks on *M. longirostris* and *M. Arvernensis* will be found in vol. ii.—[Ed.]

[2] This was written in 1846. Dr. Falconer subsequently determined that *Mastodon Sivalensis* indicated a *Pentalophodon* type. See vol. ii.—[Ed.]

[3] See Fauna Antiq. Sival. pl. xxx. figs. 1, 2, and 3; and also Appendix.—[Ed.]

[4] The Manuscript ends here.—[Ed.]

APPENDIX TO MEMOIR ON ELEPHANT AND MASTODON.

I.—Descriptions by Dr. Falconer of Fossil Remains of Elephants in Museum of Asiatic Society, Bengal, extracted from the Museum Catalogue.

A. From the Sewalik Hills.

[Of the numerous specimens of Fossil Elephant from the Sewalik hills, described in the catalogue, the following are most noteworthy.—Ed.]

No. 7. *Elephas insignis.*—Beautiful specimen of the upper maxilla, right side, of a very young animal, showing the second milk molar nearly entire *in situ*, with the fang cavities of an anterior milk molar in front: also the lower half of the alveolar canal with some of the outer laminæ of the tusk adhering to it. The tusk for the age is of very large size, probably indicating the animal to have been male. The end of the alveolus of the third milk molar is seen behind, but no part of the tooth. The specimen includes also the palatine portion of the maxillary bone, and part of the jugal apophysis of the same bone. The specimen is a good deal covered with argillaceous matrix which conceals the surfaces of the bone.

	Inches
Length of fragment	4·3
Length of molar	2·7
Width at second ridge	1·35
Greatest width behind	1·6
Height of crown at fifth ridge	1·

The enamel of the ridges is deeply grooved vertically, forming sinuous folds upon the plane of wear. The first five ridges are more or less worn, showing that the tooth had been in full wear; the last ridge intact, exhibiting the tips of five mammillæ. Diameter of alveolus of tusk, 1·2. This is a very valuable and instructive specimen, as regards the early dentition. It corresponds very closely with the specimen figured in Pl. XIX. fig. 1, of Faun. Ant. Siv., but is still more perfect.

No. 8. *Elephas insignis.*—Fine specimen comprising the anterior half of the horizontal ramus, lower jaw, left side, of a young animal corresponding very nearly in age with No. 7, and showing the same teeth. It is broken off vertically in front near the symphysis, and behind posteriorly to the molar. It shows the second milk molar *in situ* nearly entire, with the first five ridges more or less worn, the last ridge barely touched. The two first ridges partly broken off. The tooth is the second milk molar, and it agrees so exactly in every respect in form and characters with the corresponding tooth of No. 7, that it is unnecessary to give details: it might even have belonged to the same animal. Two empty fang-pits of the fallen out first milk molar are seen in front.

	Inches
Length of specimen	5·
Height of jaw to alveolar margin, at first milk molar	3·2
Thickness of jaw behind	2·7
Length of molar	2·7
Width of crown at second ridge	1·05
Ditto ditto, behind	1·6

It will be seen from the last measurement that the tooth contracts from behind forwards very considerably.

A valuable and instructive specimen.

No. 10. *Elephas* (*Stegodon*) *bombifrons* (doubtfully referred to this species).—Fragment comprising the upper maxilla, left side, containing a large tooth *in situ*; the greater part of the outer surface of the maxilla is shown vertically, together with the extremity of the pterygoid apophysis behind the alveolus. The posterior half of the crown of the tooth is broken off, leaving only four white discs of wear in front. The first ridge is entirely worn out, and the tooth must have belonged to a very large-sized adult animal, for it appears to have been the last true molar.

	Inches
Entire length of tooth	9·7
Width of crown at fourth ridge	4·1
Breadth of ivory disc of second ridge	1·2

No. 19. *Elephas* (*Loxodon*) *planifrons*.—Fine fragment, comprising the superior maxilla, left side, detached, with two molars *in situ* and the greater portion of the palate; broken off behind immediately to the rear of the posterior border of the palatum, and in front near the commencement of the diastema. The anterior tooth is well advanced in wear, and shows about seven ridges, the two anterior of which have been ground down to a common disc. The plates are expanded somewhat in a lozenge form in the middle. The enamel for an elephant is thick and a good deal waved (or plaited) in this specimen; the crown is very broad, the talon consists of about four mammillæ. The posterior molar is broken off in a line with the posterior border of the palate, and only shows four very thick ridges, which are in germ and completely covered over with cement. The greater part of the section of the tooth shows the low elevation of the ridges characteristic of *E. planifrons* and the other Loxodons. This specimen is much weathered, and there is hardly any matrix upon it.

Dimensions.

	Inches
Length of fragment	12·
Ditto anterior molar	7·
Greatest breadth of crown of ditto	3·8
Height of crown behind at the last ridge inside of ditto	2·9
Length of fragment of last molar	5·3
Height of second ridge of ditto	4·2
Width of last ridge of ditto measured at the section	3·9

No. 21. *Elephas* (*Lox.*) *planifrons*.—Fine specimen, lower jaw, left side, comprising the greater portion in length of the horizontal ramus, broken off in front about the middle of the diastema, and in rear behind the offset of the coronoid apophysis, with two molars *in situ*. The *first* is entire, being surrounded by the alveolar border and shows seven ridges, the two anterior of which have their surface broken off; the rest, with the exception of the last, being more or less worn; the ridges show the discs expanded in the middle with very thick enamel plates, which are nearly free from plaiting, and the mammillæ appear to have been thick and few in number, there being five to the last ridge. This tooth appears to be the antepenultimate or first true

molar—inferred from the comparatively small size of the jaw indicating a young adult, from the small size of the tooth and from the one behind it. The *second* is broken off about the middle and is entirely in germ, no part of it having emerged above the border of the alveolus; it shows the greater part of six ridges; the mammillæ are few in number and of large size and with very thick enamel, nearly as thick as in the stegodons: one mental foramen is visible. This is a highly instructive specimen, both as regards the middle-aged dentition and as showing the transition into the Stegodons, the enamel being very thick and the ridges comparatively low.

Dimensions.

	Inches
Length of specimen	13·5
Ditto of anterior molar	6·
Width of crown in front	2·
Greatest width at fifth ridge	3·
Length of fragment of posterior molar	4·7
Width of base of crown of last ridge	3·5
Height of enamel plate of fourth ridge	2·9

The specimen is entirely cleared of matrix, but is weathered into the reddish ochreous colour common in many of the Ava specimens. Unluckily there is no information as to whence it came.

No. 22. Elephas (Lox.) planifrons.—Fine fragment of the lower jaw, comprising nearly the whole of symphysial portion of both sides, the beak of which is slightly broken off: the whole of the horizontal ramus and greater part of ascending ramus right side; the condyle and coronoid apophysis alone are wanting. Two molars are contained in the jaw. The *anterior* one is well worn, showing about six ridges and a heel; the three anterior ridges being ground down into one common disc, and the three posterior also worn down close to the base of the crown. The discs of wear are wide, and a little expanded in the middle, the enamel thick and with very little tendency to plaiting. The *posterior* molar shows six ridges emerged from the alveolus, the two anterior of which are slightly abraded, the rest being quite intact and covered over with a large quantity of cement. It is not apparent how many ridges more are contained in the back part of the alveolus. Both molars exhibit the characteristic form of *Elephas planifrons* in a well-marked manner.

Dimensions.

	Inches
Extreme length of fragment	21·5
Height of jaw to the surface of anterior ridge of first molar	7·7
Ditto behind to third ridge of second molar	7·5
Length of front molar	5·3
Greatest width of crown of ditto	3·6
Length of emerged part of second molar	5·5
Length of diastema from anterior border of penultimate molar to upper edge of extremity of symphysis	7·

The characters of the anterior part of the jaw differ very considerably from those of the existing Indian Elephant. In the latter, the diastema descends nearly vertically from the anterior extremity of the molar, the beak is very short and the outline of the two rami is rounded, whereas, in the fossil the diastema descends obliquely forward at an acute angle with the inferior border of the ramus, entailing a long

spout to the symphysis, and this part of the ramus is thickened and much swollen out, so that the outline forms a narrow oval, instead of being round. In these respects it resembles the African Elephant, but the symphysial portion is still more elongated than in that species. The inferior border of the jaw is considerably arched anteriorly; five scattered mental foramina are visible, the largest being at the base of the beak.

No. 28. *Elephas Hysudricus.*—Mutilated cranium, broken across about the middle of the sheath of the incisive bones, with the loss of the whole of the frontal, temporal and occipital regions; perfect in the left maxillary, the whole of the palate, posterior part of diastema on both sides, and the inferior part of the incisive bones; the right maxilla broken off obliquely outwards from the inner margin of the alveolus, the fracture having removed the greater part of the molar of that side; the posterior opening of nasal fossa entire. Two molars on the left side, the anterior perfectly entire, showing ten ridges, the eight anterior of which are more or less worn, but none of the discs confluent. The enamel plate of the front accessory ridge also remains. The discs of the three anterior ridges have the enamel a good deal plaited with a narrow loop in the middle. The next three ridges have their digital extremities worn into three distinct divisions, and the mammillæ of the posterior ridges are distinct. The enamel is thick as compared with the Indian Elephant, but less so than in *E. planifrons.* The crown of the tooth forms a narrow oblong, with little obliquity in the place of wear. Of the posterior molar all the plates are in germ and concealed by the pterygoid bone, the three anterior alone being exposed by a fracture. They are seen to be very much deeper than in *E. planifrons* and to be curved forwards at the apex. The section of the incisive bones shows that the tusks were of about medium size, namely four and a half inches in diameter.

Dimensions.

	Inches
Length of palate from broken extremities of incisives	12·
Width of palate in front	3·
Ditto behind	4·
Length of anterior molar (penultimate)	8·
Width of crown in front	3·1
Ditto in middle	3·7
Ditto behind	3.5
Estimated length of last molar	11·5
Height of second plate	4·7

This is the only portion of the cranium of this species of considerable size contained in the collection. The molars are inferred to be the penultimate and last. They show well the characters of the species as distinguished from *E. planifrons.*

No. 41. *Elephas Hysudricus.*—Very fine specimen of the lower jaw left side, comprising the greater portion of the horizontal ramus broken off in front of the mental foramen, and of the whole of the ascending ramus as high as the neck of the condyle; containing the last molar *in situ*, nearly worn out, and the whole length emerged from the alveolus; the anterior part of the tooth would appear to have been worn away; the remains of twelve ridges are visible, the first three of which are

confluent into a continuous disc; all the rest except the two last are more or less affected by wear; the discs are narrow and the plates closely approximated, showing little plaiting of the enamel and not much expansion in the middle; both these characters being inferred to be owing to the very advanced stage of detrition.

Dimensions.

	Inches
Length of specimen from anterior fracture to posterior border of ascending ramus	17·
Height from plane of lower border of horizontal ramus to summit of fractured condyloid apophysis	17·7
Antero-posterior diameter of ascending ramus	8·
Vertical height of horizontal ramus, measured to outer margin of alveolar border	7·
Length of crown of molar	8·
Width of ditto in middle	3·1

This is the most perfect specimen in the collection, so far as the lower jaw is concerned.

No. 64[2]. *Elephas Cliftii.*—Fine fragment, comprising horizontal ramus of lower jaw right side, from the middle of the symphysis on to near the middle of the ascending ramus, with one finely preserved molar. This tooth shows seven ridges in full wear, with about two ridges broken off, discs a good deal depressed, and the enamel much plaited. An interrupted basal cingulum on the outside at the extremities of the valleys. The diastema slopes downwards and forwards at an acute angle with the inferior border of the ramus, and is a little concave in its outline. Three mental foramina in a nearly horizontal line, differing from what is seen in *E. planifrons*, the most anterior being the largest.

	Inches
Length of molar	7·2
Greatest width	3·8

Inferred to be the last true molar of an old animal. Presented by Col. Colvin: No. 5 in his Catalogue in 'Journ. As. Soc.' vol. v. p. 181.

B. From Ava.

No. 2. *Elephas* (*Stegodon*) *Cliftii.*—Fine specimen consisting of the superior maxilla, right side detached, with the last true molar *in situ*, the whole length of the alveolus shown with a small part of the diasteme in front, and a portion of the remains of the penultimate true molar which had been worn out. The specimen is impregnated with black ferruginous infiltration, and is sparingly covered with a gritty sandstone matrix: the last molar is nearly entire and in fine preservation, showing seven ridges and a heel: the first three ridges are well worn, the most anterior being nearly ground out, and they show a continuous transverse excavated fossa, surrounded by a continuous more or less waved belt of enamel. The 4th ridge is only slightly abraded at the apices of the mammillæ, and the 5th ridge is barely touched. The 6th and 7th, with the heel, are quite intact.

The plane of wearing slopes obliquely from the outside inwards, so that the interior side of the first three ridges is ground down much lower than the outer side. There is no mark of a longitudinal line

bisecting the tooth, as in the true Mastodons, into an outer and inner division. The ridges are a little convex in front and concave behind, determining a similar form to the valleys between them, which run across without interruption, there being no accessory mammillæ developed so as to encroach upon the valleys. The mammillæ are obtuse and closely packed; they are obscurely separated from each other by shallow grooves or fissures, and nine or ten of them may be counted on the intact ridges. Hardly any crusta petrosa is visible except between the 5th, 6th and 7th ridges. The ivory is very thick, with a rugose surface very much like that of *Mastodon latidens*. Overlapping the front ridge there is a small portion of the ivory of the penultimate molar, the remains of which had not yet dropped out.

Dimensions.

	Inches
Extreme length of crown of molar	9·35
Breadth of ditto at second ridge	4·3
Ditto at fifth ridge	4·05
Ditto at seventh ridge	3·6
Ditto of heel	2·8
Height of crown of third ridge, taken at outside	1·3
Ditto at inner	1·

Two large fangs are visible on either side in front, and another outside below the third ridge.

The crown of the tooth tapers gradually and slightly from in front backwards.

The ridges of enamel, even where intact, are very low for the size of the tooth.

	Inches
Extreme length of specimen is	13·
Height of ditto from surface of fifth ridge to fracture	8·

The characters of the crown of the tooth agree very closely in every respect with the tooth of the lower jaw figured in Faun. Antiq. Siv. Pl. XXX. fig. 5, and it is inferred to be the last true molar of the upper jaw, represented in fig. 3 of that plate. It is possible that the fragment in front which is attributed above to the penultimate molar may be an anterior ridge of the last true molar which had got detached from wearing out, in which the normal character of the tooth would be to have eight ridges and a talon instead of seven as described above. Supposed to be one of the seven jaws mentioned in the Journ. As. Soc. vol. iii. p. 365.

No. 16. *Elephas Cliftii.*—Fine fragment, comprising the horizontal ramus lower jaw, left side, with nearly the whole length of the last molar embedded in it; broken off in front at the symphysis showing a part of the diastemal ridge, and behind, a little in front of the offset of the coronoid, the fracture vertically including a portion of the fang; a single mental foramen is shown in front of considerable size. The whole of the anterior two-thirds of the crown of the molar is entirely worn out into a hollow surface of ivory without any enamel. The ivory is seen to be of great thickness. Two ridges and a part of a third are seen behind, the front one well worn, the last barely touched. An intact mammilla is seen bounding each of the rear valleys at the outside, and a considerable quantity of crusta petrosa fills up the valleys. There is no indication of a longitudinal bisecting line along the crown.

The enamel is very thick and resembles that of the upper jaw, specimen No. 2, also from Ava.

	Inches
Length of fragment	12·
Height in front, at commencement of diasteme	7·4
Height of jaw to inner margin of alveolus behind	6·6
Diameter of jaw behind at bulge of coronoid	6·7
Length of molar	9·
Greatest width behind	4·

C. From the Nerbudda.

No. 40.—*Elephas Namadicus.*—A superb cranium of *Elephas Namadicus* of enormous size, exhibiting the whole width of the occiput and occipital fossa, the foramen magnum, the temporal fossa on both sides, also both maxillaries with the last molar of each *in situ*; also part of both incisives, with the empty sheath of a huge tusk in each, and the inter-incisive fossa; also the whole length of the palate and a considerable portion of the diastema. The frontal region mutilated from the bosses of the vertex on either side on to the incisive border of the nasal opening, involving the loss of the greater part of the parietal and frontal bones and the whole of the nasals which are broken off, together with the zygomatic arches and orbits. A portion of the deeper part of the orbital fossa is shown on the right side, but considerably within the broken off rim of the orbit. The orbital ala of the sphenoid is also shown together with the spheno-frontal fissure, leading to the optic foramen and the common spheno-orbital and round foramen. The whole of the spheno-palatine region is preserved, but the occipital condyles are more or less mutilated, and the rim of the foramen magnum injured. A portion of the jugal apophysis of the temporal on both sides remains, but the glenoid surface is removed, with the exception of the inner portion on the right side near the base of the apophyses; the auditory foramen, broken off externally, is also distinctly visible on the right side. The surface of the specimen, where entire, is black and shining, as if coloured with iron, but it yields a white fracture. It is almost entirely denuded of enveloping matrix, but the incisive sheaths are filled with a hard gritty calcareous sandstone, which also occupies the cancellated cavities of the diploe where shown denuded. The skull had fortunately escaped crushing, and the mutilated part only involves that portion of the frontal region which, from its slight power of resistance, would yield first to the effects of exposure to the weather.

Dimensions.

	Feet	Inches
Extreme length from broken margin of incisives to the projecting part of the occipital boss behind	2 „	10·75
Length from anterior border of occipital foramen to commencement of diastema	1 „	10·25
Extreme width of the fragmented portion of the skull behind	2 „	11·5
Width from middle of occipital crest to fragmented border of cranium, left side	1 „	5·25
Length from base of occiput at posterior margin of foramen magnum to commencement of the diastema	2 „	1·5
Length from the protuberance of occipital boss to the interior margin of the nasal opening	2 „	1·75
Height from posterior end of grinding surface of right molar near the pterygoid to summit of right occipital boss	2 „	6·25

	Feet	Inches
Height from anterior end left molar to base of left incisive bone, at border of nasal opening	1	7·
Height from inferior margin of occipital foramen to apex of vertex, right side	1	6·25
Length of alveolar cavity measured from the inferior (distal) end of pterygoid process to commencement of molar in front, right side	1	1·
From ditto to floor of intermaxillary fossa	1	6·75
From the intermaxillary suture to the outer border of the maxillary portion of the incisive alveolus	0	11·3
Length of incisive fossa remaining	0	11·5
Width of incisive fossa near apex	0	2·6
Ditto anteriorly at fracture of incisive	0	5·6
Transverse diameter of the incisive alveolus	0	6·6
Antero-posterior ditto	0	6·2
Depth of occipital fossa from the plane of the bosses at the vertex	0	9·5
Greatest width of ditto	0	7·5
Narrowest diameter ditto between the bosses	0	4·6
Greatest length of fossa from occipital foramen to anterior fragmented margin	0	12·5
Depth of jaw from lower margin of maxilla to orbital process of sphenoid near the middle	0	10·
From posterior border of palate to broken edge of incisives	1	3·5
Width of palate in front between alveoli	0	2·2
Ditto behind	0	3·6
Length of crown of molar	1	1·
Width of ditto in front	0	4·
Ditto about middle	0	3·9

Both of the molars are *in situ* and appear to have been well worn, the crown on to the back ridges being protruded; the anterior plates had been worn out. The grinding surface is a good deal damaged by blows and abrasion, but the plates are seen to be closely approximated with narrow discs and plaited enamel. The discs expand into a loop in the middle; about 22 plates can be counted, besides some of the most anterior which have probably been worn away. The teeth are the last true molars of a large adult, and probably male, judging from the size of the tusks. An entire cranium in very good preservation of *E. Namadicus* is figured in Faun. Antiq. Siv. Pl. XII. A.; the original is lodged in the United Service Museum, Charing Cross, London; it was probably a female. The specimen above described agrees so entirely with that figure, that there can be no doubt of its belonging to the same species. The enormous width and depth of the occipital fossa which form so prominent a character in the drawing are still more exaggerated in the fossil, together with all the other characteristic marks. Unfortunately the anterior bulge of the forehead is broken off, or it might have been expected to have been still more largely developed. The crowns of the molars are better preserved than in the figured specimen, which shows only 10 or 11 plates, Faun. Ant. Siv. Pl. XII. B. fig. 3. This cranium is fully equal in size to correspond with the huge specimens of fore and hind legs from Sejouni, in the Museum, presented by Dr. Spilsbury. This specimen was found at Brimhan Ghat.—*Vide* Journ. As. Soc. vol. xii. p. 165.

No. 54. *Elephas Namadicus.*—Rare specimen, comprising a large portion of the sternum of enormous size. The mass is wedge-shaped

in section, with a deep keel below and broad above, where it shows two pairs of costal articular surfaces, and the commencement of a third pair, the bone being there broken off. The uppermost pair of discs appear to represent the junction with the first pair of ribs? The specimen was enveloped in a mass of calcareous sandstone, which left a small portion exposed. The episternal portion is wanting.

Dimensions.

	Inches
Length of the fragment	12·7
Depth at anterior end	6·3
Ditto in the middle	6·5
Width of upper surface, anterior end	4·9

The upper (vertebral surface) forms two hollows bounded by ridges, i.e. two sternal elements.

No. 1. *Elephas insignis.*—Lower jaw, left side, comprising the anterior portion of the horizontal ramus, truncated in front of the symyhysis, containing six ridges of a molar tooth, the three anterior of which are worn, the rest intact; broken off behind near the commencement of the ascending ramus; covered over with soft sandy matrix. *Vide* Journ. As. Soc. vol. xix. p. 489. This specimen is in the usual mineral condition of the Nerbudda fossils as contrasted with those from Ava and the Sewalik hills, viz. being white, soft and friable, and adhering to the tongue, there being no ferruginous or calcareous infiltration. It is of great importance, as being the only specimen of this Sewalik Stegodon from the Nerbudda in the Asiatic Society's collection.

II.—Descriptions by Dr. Falconer of Fossil Remains of Mastodon in Museum of Asiatic Society of Bengal.

A. From the Sewalik Hills.

No. 1. *Mastodon Sivalensis.*—Fine specimen of the upper maxilla left side, comprising the greater portion of the palate and two molars embedded in the jaw, with four empty pits, marking the situation of the fangs of the second milk molar which had fallen out. The third milk molar is shown nearly entire, with the enamel crown broken off at the outside of the first two ridges, and the first three ridges are seen to be touched with wear forming depressed cups. The crown of the tooth is bisected longitudinally into an outer and inner division, and the groups of mammillæ are seen to alternate, instead of being transverse with accessory mammillæ in the valleys (See Pl. IX. fig. 2). This is the normal character of the species distinguishing it alike from *M. latidens* and *M. Perimensis* (Pl. IX. figs. 3, 4, 5, and 6). The surface of the enamel is deeply grooved vertically, so that the ridges, when worn down, present a very complex pattern. Behind the fourth ridge is a talon consisting of a complicated group of small mammillæ. To the rear of this tooth, the anterior portion of the first true molar is visible in germ, and the posterior part of it is still concealed in the alveolus; it shows three ridges, presenting the same complex form as the anterior tooth, but is very considerably larger in every proportion. The four empty fang cavities in front are nearly square, showing that the crown of the tooth had a similar form, viz. that it was short and broad; these cavities are well apart from each other.

	Inches
Extreme length of fragment	7·
Height from molar surface in front to upper edge of fracture	4·3
Length of crown of third milk molar	3·2
Width of ditto in front	1·8
Ditto ditto behind	2·1
Ditto of back molar at third ridge	2·5
Length of alveolar space of second milk molar (fallen out)	1·2
Width of ditto in front	1·3
Ditto ditto behind	1·5

This is a very important specimen from showing so much of the early dentition. It is evidently a young *M. Sivalensis*, but there is nothing to indicate the locality whence it came.

No. 2. *Mastodon Sivalensis.*—Fine specimen showing the upper maxilla, both sides, with the last milk molar and first true molar *in situ*, closely resembling specimen No. 1. The specimen is broken lengthways along the palate into two fragments, and it is a good deal covered with sandstone matrix. The anterior molar on the left side has the greater part of the crown hammered off by attrition. On the right side, what remains of it shows discs of considerable wear. The back molar, on either side, is in a state of germ. It resembles No. 1 so closely, that further details are unnecessary.

B. From Ava.

No. 1. *Mastodon latidens.*—Fine specimen of the upper jaw, both sides containing one entire molar in each, and the anterior ridge behind of another molar germ. The specimen is broken off horizontally about four inches above the base of the crown of the molars, showing the floor of the nasal fossa. The palate is perfect from the posterior border to the commencement of the diasteme, where it is abruptly broken off. The teeth are in the most perfect state of preservation; the enamel is thick, rugose at the sides, and presents on the crown a clouded pearly appearance; the anterior of the molars consists of four ridges and a talon or heel ridge; the three anterior ridges are more or less worn, the fourth ridge only slightly touched in the middle; each tooth exhibits longitudinally a line bisecting it into an outer and an inner half; the ridges are transverse, the furrow intervening being unbroken, with a small mammillary process bounding the interior termination of the furrow and interposed between the ridges. These mammillary processes are chiefly seen in the first and third furrows; they are absent from the second. Each ridge near the middle throws out one or two accessory adpressed mammillæ behind, which encroach on the furrows without disturbing their continuity, causing loops of wear when the ridges are ground down; there are about six mammillæ to each ridge, the innermost of which is the largest. The talon on both sides forms a rather complicated ridge, more largely developed than in most other species of mastodon. The first and second ridge of the left molar are worn down, so as to show continuous depressed discs of ivory surrounded with a border of enamel. The third ridge shows three small discs, the outermost mammilla being hardly touched; the fourth ridge and the talon are hardly touched; on the right side, the anterior ridge forms also a continuous depressed disc, the second ridge is distinctly bipartite into discs of an irregular pattern, with a loop in each behind, caused

DESCRIPTION OF PLATE IX.

MASTODON SIVALENSIS AND MASTODON PERIMENSIS.

Figs. 1 and 2. Show in plan and profile the last upper molar of *Mastodon Sivalensis*, one-third of the natural size, and copied from drawings by Mr. Ford in Plate XXXVI., figs. 6 and 6 *a*., of the Fauna Antiqua Sivalensis. The tooth has six ridges and a hind talon and shows well the alternate disposition of the crown-mammillæ. There is a cast of the specimen in the British Museum. (See pages 117 & 467, and vol. i. p. 29.)

Figs. 3 and 4. Show in plan and profile the antepenultimate molar of the upper jaw, left side, of *Mastodon Perimensis*, one-half of the natural size. The specimen was obtained from Perim Island, and is in the Museum of the Asiatic Society of Bengal. The figure is copied from a pencil drawing executed by Mr. Claude Augier for Dr. Falconer, in 1856, and the identification of the tooth is in Dr. Falconer's handwriting upon the drawing. (See page 122.)

Figs. 5 and 6. Show in plan and profile the penultimate upper molar, right side, of *Mastodon Perimensis*, one-half of the natural size. The specimen, like the last, was obtained from Perim Island, was identified by Dr. Falconer, and is in the Museum of the Asiatic Society of Bengal. The figure is copied from a drawing by Mr. Claude Augier. (See page 122.)

Fig. 3.

Fig. 1.

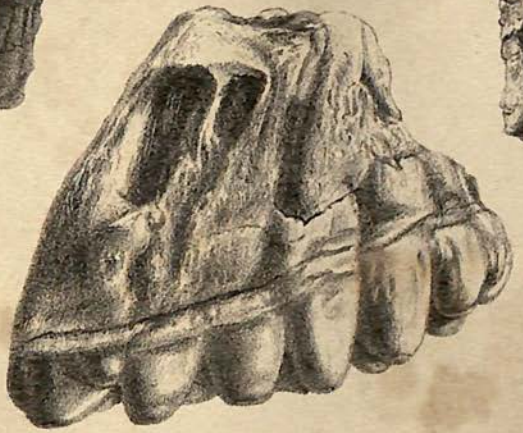


Fig. 5.

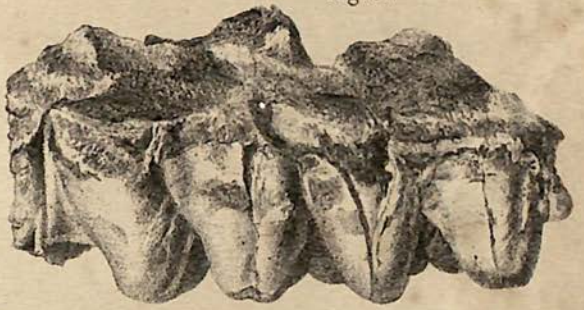


Fig. 4.

Fig. 2.

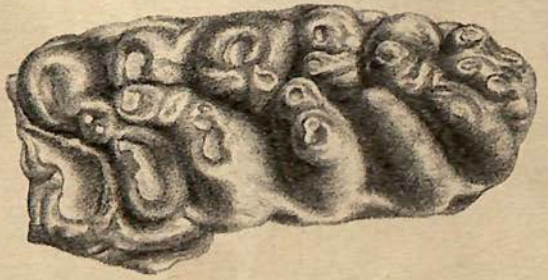


Fig. 6.

1, 2 Mastodon Sivalensis. 3, 4, 5, 6. M. Perimensis.

by the accessory mammillæ. The third ridge shows three discs, the outer mammilla being nearly intact; the fourth ridge is barely touched in the middle, and the talon is entire. The talon on the right side shows seven mammillæ, large and small, that on the left only four. The posterior molars are in a state of germ, and the first ridge only is preserved on the left side; on the right side it is broken in the middle. The posterior tooth is seen to be of much larger size than the anterior one; the first ridge consists of about five mammillæ, with an accessory mammilla behind the first and second. A portion of the enamel border of the anterior ridge of the left molar is broken off on the outside.

The enamel is very thick; there is no appearance of crusta petrosa on the furrows. The rugosity of the surface runs in transverse wavy grooves or meshes somewhat as in the enamel surface of Rhinoceros, but more marked.

In front of the right molar, inner side, there is a nearly obliterated pit of one of the fangs of the molar preceding it which had been shed. There is no trace of this on the left side, where the molar is more advanced in wear, having been protruded earlier.

The bony surface of the specimen when unbroken is generally tinged of a brownish red colour.

This specimen is singularly free from matrix, of which not even the smallest portion is visible upon the discs of wear, or in the crevices between the teeth. In this respect it resembles a fresh macerated bone. A black shining surface covers the upper side irregularly, upon which thin gold leaf has been freely dispersed. This, when tested by a hot iron, proved to be caused by a coat of Thee-tsee varnish so commonly used by the Burmese for lackering. This was evidently an artifice to enhance the supposed value of the specimen, which appeared to the Burmese King worthy of being made a royal present, and was so offered to the Governor-General of India, by the Burmese Embassy at Calcutta, in December, 1854.

Dimensions of Molars.

	Right	Left
Length	6·35	5·95
Width of crown in front	3·5	3·45
Ditto ditto behind	3·65	3·6
Height of crown in front exteriorly	1·25	1·15
Ditto ditto interiorly	1·	0·85
Ditto ditto behind exteriorly	2·05	2·1
Ditto ditto ditto interiorly	1·8	1·75
Width of first ridge posterior molar	—	4·15
Exterior height of ditto ditto	—	2·3

Other dimensions.

Breadth across the two molars anteriorly	8·3
Ditto ditto posteriorly	10·3
Width of palate between molars anteriorly	1·5
Ditto ditto posteriorly	3·15
Length of palate	8·1
Extreme width of jaw behind	10·7
Greatest height from crown of molar behind to upper surface of fragment	6·5
Thickness about middle between surface of palate and floor of nares	2·35

No. 3. *Mastodon latidens?*—Specimen consisting of the horizontal ramus of lower jaw left side, truncated obliquely downwards and backwards in front of the molar and behind about the middle of the ascending ramus, of which it shows a part. The specimen is dark-coloured from ferruginous infiltration and is sparingly covered with a thin crust of gritty calcareo-arenaceous matrix, resembling that found on the surface of many of the Ava fossils. The whole length of the molar tooth is visible *in situ*, but unfortunately all the enamel surface of the crown is broken off, so as to deprive us of any direct and conclusive evidence as to the species, but it is evident that the tooth is the third or last true molar, as the section behind shows no marks of the nucleus of another successional tooth to come after it; but from the narrowness of the crown, it is confidently inferred that the specimen belonged to a true Tetralophodon mastodon (either *M. latidens* or *M. Perimensis*) and not to *E.* (*Stegodon*) *Cliftii*. The jaw is characterized by its great transverse diameter behind and great height in front. The removal of the symphysis has carried away the outer orifices of the mental foramina, but two canals are seen in the section which also exhibits a nearly cylindrical core, which is probably the residuum of the fang of a shed molar or a tusk of the lower jaw?

Dimensions.

	Inches
Extreme length of fragment from broken edge *viâ* symphysis to broken edge behind	16·7
Height of jaw measured outside immediately in front of molar	8·5
Ditto ditto behind	6·7
Greatest diameter behind, taken at bulge of ascending ramus	·8:
Diameter in front in a vertical line with the anterior edge of the molar	5·4
Extreme length of alveolus and crown of molar	10·
Diameter of crown of molar in front	2·4
Ditto where widest behind	2·8

The tooth narrows very much from behind backwards, as seen in the section; the residuary portion of the crown of the molar viewed from the inside in front is elevated 1 to 6 inches above the alveolar border. There is no portion of the enamel visible except an edging on the outer side.

The form of the lower jaw is much thicker and shorter in proportion than in the existing Indian elephant, further supporting the conclusion that it belongs to a true mastodon.

This is a valuable and characteristic specimen; and it is much to be regretted that there is no tracing its origin in the records of the Asiatic Society. Is it one of Col. Burney's specimens from Ava?

No. 4. *Mastodon latidens.*—Fragment of lower jaw left side, comprising part of horizontal ramus from base of coronoid apophysis to about 6½ inches forward, containing the posterior half of a well-preserved molar, which is inferred to be the last or third true molar from the absence of the indication of any other forming behind. It shows four ridges with a talon, the three anterior of which are well worn, showing that the animal was fully adult. The tooth agrees in the closest manner in size, form, amount of wear and every other respect with the corresponding specimen figured in Faun. Ant. Siv. Pl. XXX. fig. 6, which, however, has a ridge more in front preserved.

The anterior ridge of the specimen is worn into a deep transverse disc, of which the anterior boundary edge of enamel is wanting. The second and third are also worn into continuous excavated discs; the fourth shows the caps of three large mammillæ slightly touched, and the talon consisting of three mammillæ in a transverse row is intact.

The accessory mammillæ described as bounding the valleys on the inside of the Burmese Embassy specimen (No. 1) are shown of very large size in this specimen.

Dimensions.

	Inches
Extreme length of fragment	8·
Height of section in front	7·8
Ditto ditto behind	6·2
Diameter behind	6·55
Length of fragment of molar	6·1
Greatest width in front	4·1
Height of enamel crown in front	1·4

The colour of the specimen differs from most of the Ava fossils in absence of a ferruginous tint, and the enamel is greyish and pearly, looking as in No. 1: very little matrix upon it.[1]

No. 5. *Mastodon?*—Fragment of lower jaw, left side, divided longitudinally nearly in the middle, jet black in colour, with a small quantity of sandy matrix; no indication of a tooth or alveolus but segment of a canal (dentary?) running longitudinally near the inferior border. The fragment is in two joined pieces.

Extreme length, 11½ inches.

Identification very obscure.

No. 6. *Mastodon latidens.*—Fragment of molar divided vertically and lengthways, consisting of the back part with three well worn ridges and a talon, and one great posterior fang. The end of the talon bears upon its ivory surface the disc of pressure of a molar behind. The enamel is very thick, and in every respect as in specimen No. 4. The worn surface of the discs agrees exactly with those of the Ava specimens figured in the Fauna Antiq. Siv. Pl. XXXI. figs. 7, 8.

	Inches
Extreme length of specimen	3·5
Height from fang to surface of crown	3·5

No. 7. *Mastodon?*—Fragment consisting of the last ridge and talon of a molar tooth, with the mammillæ in germ and entire. The mammillæ numerous and closely aggregated together. Species indeterminable.

No. 28. *Mastodon.*—Proximate phalanx of hind leg, very thick and massive, highly coloured with iron infiltration.

No. 29. *Mastodon.*—Mutilated fragment of a large massive acetabulum in two pieces, black and heavy like a mass of iron.

[1] The engine turned-like marking, resembling that of a watch-case, which Owen states to be 'peculiar to the tusks of Proboscidian Pachyderms,' is distinctly visible at the posterior *end of the ivory* in this molar, showing that the ivory of the tusk does not differ in structure from that of the molar. The term '*dentine*' is therefore untenable: *Vide* Owen, 'Odontography,' p. ii. Introduct. and p. 627.

No. 30. *Mastodon.*—Dorsal vertebra; apophysis broken off; body compressed and showing very approximated costal articulations. Transverse diameter of body 3·8 inches; antero-posterior diam. 3·5 inches; thickness 2 inches. Very small for a proboscidean vertebra; highly infiltrated with iron.

C. From Perim Island.

No. 1. *Mastodon Perimensis.*—Permanent molar, upper jaw, left side, with four ridges complete, first ridge worn (antepenultimate). Characteristic specimen. (See Pl. IX. figs. 3 and 4.)

No. 2. *Mastodon Perimensis.*—Upper molar, right side, probably penultimate, with four ridges, the first two worn. Characteristic specimen. (See Pl. IX. figs. 5 and 6.)

No. 13. *M. Perimensis.*—Molar, unworn, with four ridges and talon; anterior portion wanting; highly characteristic.

No. 16. *Mastodon?*—Humerus, lower end, left side, huge size, in two pieces. The largest known.

No. 17. *Mastodon?*—First vertebra of neck (atlas) of large size, very complete.

No. 18. *Mastodon or Elephant.*—Cervical vertebra, in two pieces; left half of neural arch broken off and lost, belonging to an animal of enormous size.

No. 19. *Mastodon or Elephant.*—Dorsal vertebra (anterior), nearly complete. Spinous process of enormous size broken off; costal cup present on left side.

No. 20. *Mastodon or Elephant?*—Lower extremity of a femur, right side, in two pieces, of very remarkable form, with a considerable portion of the shaft attached. The condyles are covered with Perim matrix, which has become partly engrained with the bone, but the general contour is visible, agreeing closely with the elephants and mastodons. The shaft, however, gradually contracts from above the condyles into an attenuated and comparatively slender shaft, such as is unknown among these types, fossil or recent. The section of the shaft is a compressed oval, with a very sharp edge at the outer side. Can this be a femur of Dinotherium? There are no ascertained remains of that genus in the collection.

Dimensions.

	Inches
Length of fragment	19·5
Greatest width above condyles	7·5
Antero-posterior diameter of condyle	6·
Transverse diameter of shaft at fracture	4·1
Antero-posterior ditto	2·5

No. 102. *Mastodon Perimensis.*—Fragment comprising a portion of the horizontal ramus of the right lower jaw broken off vertically in front of the penultimate molar, and behind at the commencement of the offset of the coronoid process, showing the entire molar alveolus, together with the hollow alveolus of another molar behind. The molar unluckily has the crown very much mutilated, but it distinctly shows the masses of four ridges, bounded by a large fang in front and

also behind. A depressed disc, bounded by a belt of enamel, shows that the first ridge was partially affected by wear; and a similar character shows that the second ridge was slightly touched. A great part of the enamel on the right side of the ridge remains entire. The third and fourth ridges are completely denuded of their shell of enamel, but they were probably quite intact. The first and second ridges, which remain, show the longitudinal bisecting line. The valleys are transverse, but it is seen that they are interrupted in the middle by an accessory lobule in front and behind each ridge. Their outer termination is bounded by a large depressed mammilla exactly as in *M. latidens*. The enamel is very thick, and shows deep rough lines of longitudinal grooving. The mammillæ of the ridges appear very high, and it is seen that the accessory lobules in the furrows form a projecting loop to the disc of depression exactly as in *M. Perimensis*.

Dimensions.

	Inches
Length of fragment	8·8
Height from lower surface of ramus to alveolar margin, outside	7·4
Transverse diameter of ramus at posterior end of tooth	6·5
Length of molar	7·
Width about middle	3·5
Height of crown at second ridge	2·6

Nothing more than the cup of the last molar is shown behind. The lower edge of the ramus is broken off, and shows a canal of about 1½ inch in diameter, running longitudinally. The nature of this is doubtful.

This jaw is seen to be of less diameter proportionally than the jaws attributed to *M. latidens*, more especially the Ava specimen No. 3. There is hardly any matrix to indicate whence the specimen came, and there is nothing of the yellow marly conglomerate generally found on Perim Island fossils. But the characters of the tooth are so close to those of *M. Perimensis* that it is attributed to that species. It is much to be regretted that no record has been kept of the history of this specimen, or where it came from. [After having gone over all the collections, the opinion arrived at is that this and the next specimen, No. 103, are more likely to have been from Ava than Perim Island.—23rd Feb. 1855.]

No. 103. *Mastodon latidens.*—Fragment of the horizontal ramus, lower jaw, right side, broken off near the symphysis in front, and immediately behind the molar in rear; broken also at the lower border. It contains an entire molar *in situ*, being the first of the true molars, and the remains of a worn-out milk molar in front. The crown of the tooth, which is well worn, shows four distinct ridges, the three anterior of which are ground down each into a continuous broad disc, showing, about the middle, the characteristic loop of enamel in front and behind, which indicate the accessory mammillæ situated about the middle of the valleys. The last ridge shows two discs, which are distinct, although nearly confluent. The talon is barely touched by wear.

	Inches
Length of fragment	6·1
Height ditto to crown of molar in front	4·7
Ditto ditto behind	5·3
Length of molar	4·1
Width of ditto at second ridge	1·8
Ditto ditto fourth ridge	2·2
Length of fragment in front of molar	1·7

No mark. There is some sandy matrix sparingly covering the fossil, not like the ordinary Perim matrix. But the characters of the tooth are entirely those of *Mastodon latidens*; a younger tooth closely resembling it contained in the Scinde collection, No. 2.

D. From Scinde.

No. 1. *Mastodon latidens.*—Fragment of large upper (?) molar, comprising two ridges, little touched by wear. The only complete furrow present is transverse without interruption, as in the Ava specimens. The longitudinal bisecting cleft is very distinct. The weathered appearance is peculiar, differing from anything else in the collection. The teeth appear to have been embedded in a yellowish clay.

No. 2. *Mastodon latidens.*—Third milk molar, lower jaw, left side (?), showing the posterior two and a half ridges and the heel, all well worn. The two last ridges are supported on a large fang. The anterior, with the whole of the first and half of the second ridge, are broken off. The valleys are transverse, without interruption. *Vide* Perim Island specimen, No. 103.

No. 3. *Mastodon latidens.*—Portion of a second milk molar, showing two ridges and a low talon ridge supported on one fang. The valley very open. Found in a low range of sandstone breccia, composed of angular pieces of nummulitic limestone cemented with clay, at Sehwan on the north side of the Jukkeo Hills.

III.—Mastodon (Triloph.) Pandionis.[1] Description by Dr. Falconer of Fossil Molars from the Deccan, presented by Colonel Sykes to the India House Collection.

(*Extracted from Note-book: 24th December*, 1856.)

No. 1.—The principal piece is a penultimate molar, upper jaw, left side: so determined from comparison with a germ specimen from M. Lartet of an antepenultimate. The crown of the tooth is perfectly entire, the front ridge alone being a little touched by wear on the inner side; but the fangs and base of the tooth are broken off right across on a line with the termination of the enamel shell. It exhibits three well-defined ridges, with a thick strong front talon, and a hind talon confluent with the last ridge. It is a true and unmistakeable *Trilophodon*—the only one yet yielded by India, and very different in its crown characters from all the Sewalik, Ava, or other fossil Mastodons of the East.

The general form of the crown resembles very strongly that of *Triloph. angustidens*, the principal difference being that the 'col' of vallecular flanking mammillæ is still more developed than in that species. The crown is traversed, as usual, by an indistinct longitudinal cleft along the axis, marking off an outer and inner division. Each of the three ridges has the outer division simple and composed of a thick

[1] Dr. Falconer described the first specimen as belonging to a new species, *Mastodon Andaranus*. (From Pliny, Nat. Hist. vi. cap. 19, 'Validior deinde gens Andaræ plurimis vicis, &c. The 'Andhra' race of kings (Wilson), south of Godavery.)

The second, he regarded as identical with a specimen of *M. Pandionis* in the collection of M. Lartet, and its description is headed *Mast. Andaranus*, nunc *M. Pandionis*.—[Ed.]

conical transverse mass, the summit of which is somewhat compressed, and indistinctly bi- or tri-lobed, by corresponding longitudinal furrows. The inner division is more massive and complex, each ridge throwing out from its anterior and posterior surface—the former diagonally forwards, the latter diagonally backwards—a 'col' of robust tubercles, which meet in a chevron form in the middle of the valley, so that, when the inner division of the crown is regarded in plan apart from the outer, it presents, in conjunction with the outlying tubercles, a series of zig-zags closely resembling the letter W. The complexity of pattern is further increased by the salient apex of the connecting 'col' being continued outwards towards the margin in a single line of cylindrical mammillæ, which completely obliterate the bottom of the outer half of each valley; while the inner half, corresponding with the re-entering angle between the large inner cones, forms a gorge which is entirely free from tubercles. The anterior talon forms a subordinate ridgelet, which is thrown off in the usual manner from the anterior portion of the inner cone, and is continued outwards towards the margin, with less inclination downward than is ordinarily the case in the other allied species. It is composed of about four robust compressed tubercles, which are separated from the anterior ridge by a well-marked chasm. The posterior talon consists of a cluster of indistinct confluent tubercles thrown off from the posterior part of the inner tubercle of the last ridge, and so adpressed to the ridge that it does not yield the defined and separate appearance seen in the talon of *Triloph. angustidens*. After a little wear, the posterior talon would be involved in the disc of detrition of the last ridge.

No. 2.—Among the teeth presented by Col. Sykes there is also a small two-ridged Mastodon tooth, with very smooth enamel, which in form, through every detail, agrees so exactly with a specimen of Lartet's, that I unhesitatingly consider them to be homologous teeth of the same side, and nearly of the same age.

Dimensions of Premolar	Lartet's	Indian
Extreme length	1·75	1·9
Width of front ridge	1·1	1·15
Ditto of back ridge	1·4	1·4

Lartet's specimen is a detached tooth, labelled in his list, 'Last *lower* premolar, left side.' It consists of two ridges, both of them worn; but the outer and inner discs not continuous, and the middle of the valley occupied by a tubercle, which is worn low down, leaving a circular disc. There is a well-marked anterior talon, of two worn tubercles, but deeply impressed by an anterior disc of pressure against a preceding tooth in position. Behind, there is also a talon, but very strongly impressed by a disc of pressure, so that the posterior talon only exists on the inner side. The crown presents the cucumber shape, so remarked on by De Blainville—i. e. the first ridge is narrow, the second broad.

The Indian fossil shows precisely the same characters—i. e. two ridges worn, and two talons, with a connecting tubercle between the ridges. The back talon is marked with a disc of pressure,

but the anterior talon consists of two confluent prominent tubercles, free from any mark, showing either that there was no penultimate premolar, or that it was very caducous, and dropt out without pressure from behind. The anterior ridge is narrow; the posterior broad, as in Lartet's; but the ridges are more worn, and the discs confluent. The crown slopes from the inside which is higher, to the outside which is lower, but less so than in Lartet's. The intermediate tubercle is worn down as in his, and the posterior talon is only exhibited free on the inner side.

The specimens are so exactly alike that they might have been taken for the same species, but that the Indian is a little larger.

IV.—Note on the Teeth of the Mastodon à dents étroites of the Sewalik Hills. By Captain P. T. Cautley.[1]

(*Read at the Meeting of the Asiatic Society of Bengal, June* 1, 1836.)

Without further preface I refer the reader to the 1st volume of the Ossemens Fossiles, page 268. Figs. 1 and 2, Plate IV., under the head of 'Divers Mastodons.'

These drawings were presented to Cuvier by M. Faujas, and the fossil was found near Asti in Upper Italy.

Cuvier merely alludes to this fossil as one of the varieties into which the true Mastodon *à dents étroites* passes by a greater subdivision and an irregularity of position of the mammillæ; the proportions of length to breadth of the tooth retaining their full and perfect character.

By comparing the accompanying drawings with the figures above alluded to, there can be no demur, I imagine, in identifying the Sewalik variety of Mastodon now under review with the Asti fossil. It remains therefore simply to note the peculiarities in form of the tooth: although it may be a point for consideration hereafter, whether, as the character of the tooth is so marked, and its peculiarities so rigidly adhered to throughout the whole of the remains found in the Sewaliks, it may not be placed under a sub-genus, that of '*angustidens*,' with the specific denomination of *M. Sivalensis*.

There is no cortical substance or crusta petrosa; the tooth consisting of enamel and ivory only, the former being very thick and massive, as is normal in the mastodons.

The coronal surface consists of a double line of conical and obtusely pointed mammillæ: those on the external side being in most cases perfect, whilst those on the inner side are divided by a fissure or fissures into two or three irregularly formed obtuse points. These mammillæ are not, as in the true *Mastodon angustidens*, placed transversely or at right angles with the line of surface, but meet each other from right to left alternately, so that the furrow on one side is interrupted by the mammilla on the other; and the mammillæ on the whole line of tooth lock into each other in the same way that two serrated edges opposed to each other might be supposed to do, were they placed in contact. (Pl. IX. fig. 2.)

The outer surface of the enamel is smooth, and the space or furrow between each mammilla both on the external and internal surface is marked by a small tubercle, the presence of which however does not appear to be constant.

[1] Reprinted from the Journal of the Asiatic Society, vol. v. p. 294.—[Ed.]

The surface of the tooth of the lower jaw wears obliquely and outwardly on the grinding surface, as in the ruminants, in which respect it differs entirely from the elephants.

The wear of the coronals is marked at the commencement by irregularly lobed figures, which, as the detrition advances, become confused and gradually unite, until the mammillæ are worn away entirely, when the tooth is left with merely a surface of ivory surrounded by enamel.

The drawings are intended to represent the tooth at these different stages;[1] from the state of germ, to the old and worn down tooth, showing the intermediate state of detrition at different ages.

I wish to draw attention particularly to the alternating position of the mammillæ, which I consider to be the chief specific character, and which is distinctly marked throughout the whole series; and, referring again to the Asti fossil as figured in Cuvier, I think that a clear identification is established. (See Pl. IX. fig. 2.)

As my object in writing this note is simply to point out the distinctive characters of the teeth of the mastodon *à dents étroites*, which has been found in the Sewalik hills, it is unnecessary to make any further remarks until we can enter upon a general description of the fossil mastodons and elephants of these hills; noting, however, that from the half of a lower jaw of this species, with its ramus attached, which is now in my possession, we may look forward to some peculiarities of form, differing very materially not only from the fossil and existing elephant, but also from the other species of mastodon.

Up to this period I am only aware of the discovery of two species of mastodon in the Sewalik hills; namely, the *variety* of *M. angustidens* which is the subject of this note, and the *M. Elephantoïdes* of Clift. The former is very rare, and the latter in very great abundance.[2]

V.—Note on Mastodons of the Sewaliks. By Capt. P. T. Cautley.[3]

In the present state of the researches into the fossil remains of the Sewaliks, it will be interesting to note any discovery of peculiar interest, without entering upon a description in detail. Such a description may, with propriety, be reserved, until the possession of a more perfect and a more numerous collection of remains enables us to enter upon the description with greater confidence: whilst, in the meantime, to those who are interested in the study the periodical announcement of progress made in our operations cannot be devoid of interest; under this idea I did myself the pleasure of forwarding to your Society the note on the dentition of the *Mastodon angustidens* (variety of), and now send you one on a skull of another variety of Mastodon which has been lately received. The sketches are drawn on transfer paper, and will, I hope, be intelligible.

Figs. 1 and 2 are representations of the fossil skull—Fig. 1 being the front, and Fig. 2 the profile or side view. Figs. 3 and 4 are similar

[1] The reader is referred to the descriptions by Dr. Falconer, in the Fauna Antiqua Sivalensis. Plates xxxii. to xxxvii.—[Ed.]

[2] The former is the *Mastodon Sivalensis*; the latter includes the *Elephas insignis* and *E. Cliftii* of the Fauna Antiqua Sivalensis.—[Ed.]

[3] Reprinted from the Journ. As. Soc. Dec. 1836, vol. v. p. 768.—[Ed.]

outlines of the existing elephant, on a scale of one-eighth on linear measurement.[1]

The fossil is exceedingly perfect in some respects. The left orbit and maxillaries are as sharp and well defined as in the recent skull; the frontal and nasals are tolerably perfect, the specimen is fractured obliquely, removing the temporal swellings and diploe of the cranium, together with the occipital condyles and foramen magnum; the curve of the occipital on its external surface is however retained, and although sutures are altogether wanting, and the alveoli of the tusks are mutilated, the specimen may be considered as sufficient to give a perfect idea of the form of the skull; and, as a form perfectly unique amongst the proboscidean pachydermata, will be looked upon with satisfaction by all those who take interest in the additions that have of late years been so rapidly made to palæontology, and to the catalogue of animals now no longer existing on the globe. The present skull derives additional interest from its being so different from the only type of the same genus or co-genus (for it may be permitted so to designate the elephant) which has been left to us—so different, indeed, as to completely modify the construction of the head, and the arrangement of the muscular and fleshy matter that must have belonged to it.

Without entering into any minutiæ of detail on the peculiarities of the head, of which the drawings will give a representation, and which detail will be reserved until our collections enable us to bring under one view all the varieties of this genus that the Sewaliks may contain, it will be sufficient, in announcing this very interesting addition to our cabinet, to draw attention to a few leading points.

In the skull of the existing elephant, the excess of longitudinal measurement, over that in the contrary direction, owing to the great development of the superior portion of the cranium, is one of the most marked peculiarities of its form; the height from the external nasal opening to the top or apex of the cranium is immense, although undergoing modification from age; this excessive development not being derived from any increase of size in the cerebral cavity, but from a wide space composed of cellular bone or diploe, giving an external and deep covering to all that space occupied by the brain; the size of the orbit is small in comparison to the temporal region; the large external nasal aperture is situated between the orbits; and the front in the Indian species is slightly depressed. Now in turning to the fossil, we find that the whole of these peculiarities are either reversed, or modified in an extraordinary degree.

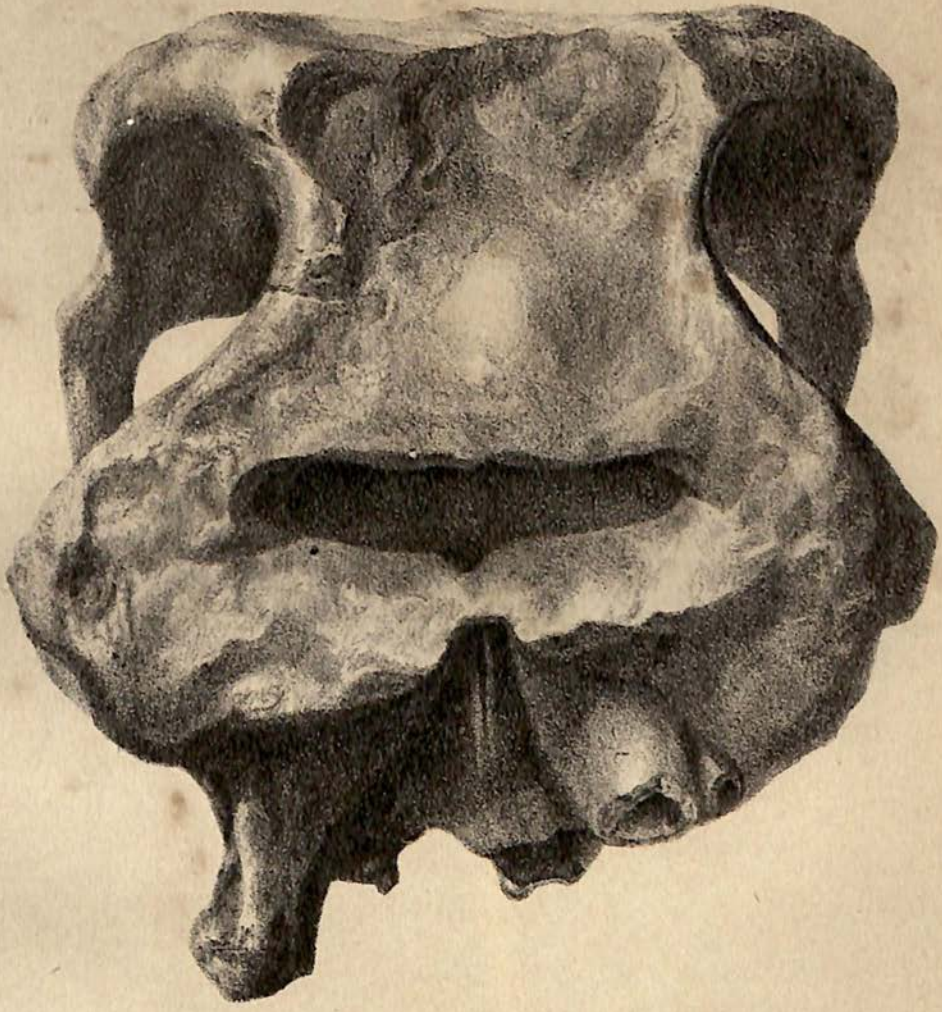
The elevated and massive cranium does not exist, the slope towards the occipital and foramen magnum commencing from the top of the external nasal opening and falling off to the rear in an abrupt angle; the size of the orbit is large, and its encircling bones massive and prominent; the space between the orbits to the front continued up to the nasal opening is depressed to an enormous extent, and the two lines of alveoli of the tusks strongly marked; the temporal fossæ are small in comparison to those of the existing elephant, and the temporal bones, which although broken off in the specimen from which the drawing is taken, exists in another skull in our possession,

[1] The original figures have not been reproduced, but a fine specimen of *M. Sivalensis* is represented in Plate x.—[Ed.]

DESCRIPTION OF PLATE X.

Mastodon Sivalensis.

Cranium of *Mastodon Sivalensis,* one-fifth of the natural size. Copied from a drawing by Mr. Scharf in Plate XXXII. of the Fauna Antiqua Sivalensis. The specimen is in the British Museum. (See pages 129 & 464.)



G. Scharf del. J. Dinkel lith. W. West imp.

Mastodon Sivalensis.

appearing to be large and composed of cellular bone. The angle formed by the tusks with the grinding surface is more obtuse than in the existing elephant, and the form of head, instead of possessing the proportion assimilating the skull of the elephant to that of man, may be considered as nearly square, or perhaps possessing a breadth in greater proportion than the length. The height of the maxillary bones, which is great in the elephant, is here much exaggerated, and the form and profile especially is so peculiar, that a glance at the sketch will, by comparison with that of the existing elephant also given, be sufficiently striking.

The suborbitary foramen is by no means large; the proportion of diploe in the upper part of the cranium bears no comparison with that in the existing elephant, these differences, combined with the peculiarity of form and position of the external nasal aperture, may, in all probability, modify the extent to which this variety of Mastodon was provided with a trunk; but to forbear from surmises or speculations in the present imperfect state of the inquiry, it will be sufficient to place this as a second to the *angustidens* formerly noted.

P.S.—A letter this moment received from Captain Cautley announces the discovery of a superb specimen of the *Mastodon angustidens*, a skull with both lines of molars, palate, and one orbit entire.[1] He adds: 'We have much still to learn of these Mastodons. With regard to the *Mastodon elephantoïdes* of Clift, there are evidently two species, of the same character as to dentition, but with a remarkable difference in the form of the cranium, one of which has the flat and the other the elevated crown.'—*Ed. Journ. As. Soc.*

[1] A fine specimen of *Mastodon Sivalensis* is represented in Pl. x., which is copied from Pl. xxxii. of the Fauna Antiqua Sivalensis.—[Ed.]

IV. ON THE FOSSIL HIPPOPOTAMUS OF THE SEWALIK HILLS.[1]

BY HUGH FALCONER, M.D., AND CAPTAIN P. T. CAUTLEY.

(*Read 3rd February*, 1839.)

FROM the abundant remains of this genus that have been procured from the Sewaliks, and particularly the perfect specimens now in our possession, we are at no loss in recognizing the characters which distinguished the Sewalik species so remarkably, not only from the existing Hippopotamus of Africa, but also from the fossil species hitherto found and described.

The great point of peculiarity is that the Sewalik fossil has six incisors of a character peculiar to itself, independent of the form of the cranium, which differs very materially from other varieties. The numerous fragments in our collection enable the proportions of the bones of the head and face to be very tolerably ascertained; and these, added to three nearly entire skulls, one of which is that of an animal just approaching adult, and the other two of a more advanced age, are so perfect as to leave no doubt of the characteristic distinctions of one or more new species.

To the fossil variety now to be described, we propose the name *Sivalensis*, a name so far applicable as attaching it to its locality, and commemorating the region in which its remains have been scattered in such profusion.

In the African Hippopotamus, figured by Cuvier and so fully described in the first volume of the 'Ossemens Fossiles,' we find the incisors consisting of four slightly curved teeth in the upper, and in the lower jaw four straight teeth projecting forwards at an obtuse angle with the plane of the grinding surface, the two centre ones being of considerably larger proportions than the others, and being formidable weapons either for tearing the roots and weeds, from which the animal derives its nourishment, or for defence. In the fossil Hippopotamus before us, these large and powerful teeth are replaced by others of a smaller size but in a greater number, there being no less than six, those in the upper jaw being slightly

[1] Reprinted from the 'Asiatic Researches,' vol. xix. p. 39. Numerous drawings illustrating almost every bone in the skeleton of the *Hippopotamus* (*Hexaprotodon*) *Sivalensis and Merycopotamus dissimilis* will be found in the Fauna Antiqua Sivalensis (Plate lix. *et seq.*) The illustrations in this reprint are copied from the Fauna.—[ED.]

DESCRIPTION OF PLATE XI.

Hippopotamus (Hexaprotodon) Sivalensis.

Figs. 1, 2, and 3. Upper, palatal, and lateral views of cranium of *Hippopotamus Sivalensis*, one-eighth of the natural size. Copied from drawings by Mr. Ford in Plate LIX., figs. 1, 1 *a*, and 1 *b*, of the Fauna Antiqua Sivalensis. The specimen is in the British Museum. (See pages 131 & 499.)

Fig. 1.

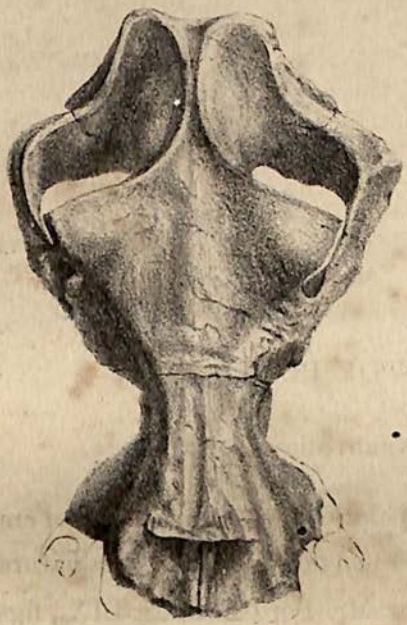
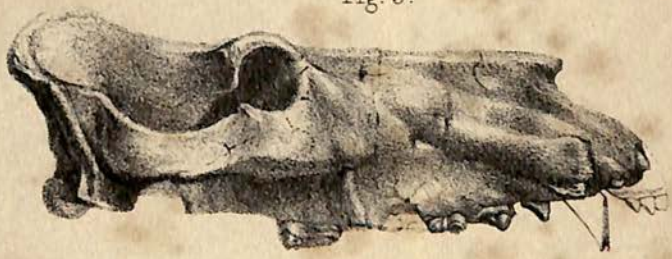


Fig. 2.

Fig. 3.



G.H.Ford del. J.Dinkel lith. W.West imp.

Hippopotamus (Hexaprotodon) Sivalensis.

curved downwards, and those in the lower projecting forwards (Pl. XII. fig. 3); the diameter of these teeth, which are cylinders with truncated ends, is less in the upper than in the lower jaw, and the central teeth may be considered as being in some degree larger than those on the right and left. When we advert to the uses to which the incisive teeth of this unwieldy animal are applied, the means of tearing up the food, and the sieve to cleanse that food afterwards,[1] we see in this form of tooth and this arrangement of the muzzle, an adaptation to the wants as perfect as, although for defence less powerful than, in the existing species. With the six incisors our fossil animal has the canine teeth of the upper jaw with a reniform outline in transverse section, whilst that of the lower jaw is pyriform, or pear-shaped. The molars resemble those of the existing species, and are numerically the same; the first milk or deciduous tooth which, as in the horse, falls and is not again replaced, is here also conspicuous.

In proceeding to a comparison between the fossil head and that of the Cape Hippopotamus, we are at once struck with the position of the orbit of the Sewalik fossil. Viewing it in profile, the orbit is considerably more advanced, and the general contour of the head thereby modified (Pl. XI. fig 3);—taking a measurement from the posterior extremity of the occipital condyle to the anterior ridge of the orbit, and from that point to the front of the muzzle, we have in the existing animal a proportion of 3 to 5, and in the fossil 9 to 13½, giving to the orbit of the latter a more central position on the face; this peculiarity leads to the muzzle and the zygomatic arch being separated by a hollow much more abrupt and much shorter on its antero-posterior line than in the Cape Hippopotamus (figs. 1 & 2). The anterior termination of the zygomatic arch on the malar angle is more acute, and the general form of this arch more prominent. The temporal fossæ are longer, and the temporal apophysis in its descent to join the malar bone is slightly inclined forwards, placing the posterior angle of the zygomatic arch in a more advanced position, and more in front of the occipital surface, than in the existing animal. The occipital crest is also more elevated, and the general appearance differs, owing to this position of the orbit; which, as will be naturally concluded, leads to a different proportion in the bones of the head, those of the cranium being lengthened, whilst those of the face are shortened in proportion respectively. In the suture separating the temporal apophysis from the jugal, we see the same direction and inclination as in the existing animal.

[1] *Vide* Lancet: Professor Grant's Lectures.

We will here introduce the table of measurements, in juxtaposition with Cuvier's of the Hippopotamus of the Cape and of the European fossil.

Dimensions of Skull	Existing Hippopotamus		Fossil Hippopotamus					
	Africa		Europe		Sewalik 1st		Sewalik 2nd	
	Inches	Mètres	Inches	Mètres	Inches	Mètres	Inches	Mètres
Length from the posterior surface of occipital condyle to the alveolus of the middle incisors	...	...	...	...	...	...	22·6	·566
Length from the upper margin of one orbit to the other, to the rear.	9·85	·249	11·85	·300	...	...	12·4	·315
Ditto greatest width of zygomatic arches	15·75	·400	17·7	·450	...	...	14·4	·366
Width of head over the sub-orbitary foramen	4·75	·120	5·7	·145	3·75	·95	4·34	·110
Height of ditto ditto from the border of alveoli	5·1	·130	6·3	·160	4·45	·114	5·3	·134
Distance of posterior extremity zygomatic apophysis of malar from sub-orbitary foramen	10·65	·270	13·4	·340	...	...	11·25	·285
From ditto to the middle of occipital crest	10·25	·260	12·6	·320	...	...	10·25	·260
Antero-posterior diameter of orbits	2·8	·070	3·55	·090	2·30	·058	2·63	·067
Greatest interval between inner side of zygomatic arch and surface of cranium	5·1	·130	5·1	·130	...	...	3·8	·096
Height of head from posterior border occipital foramen to top of occipital crest	5·5	·140	7·5	·190	5·7	·144	6·8	·173
Width of head between inferior angles of occipital crests	11·0	·280	12·8	·325	8·8	·224	9·7	·246
Length of occipital foramen	2·0	·050	2·6	·066	2·0	·050	2·48	·062
Width of ditto	1·6	·040	1·6	·040	1·3	·032	1·5	·038
Length of line of molars	10·25	·260	11·85	·300	10·5	·266	9·48	·240
Distance between alveolus of first molar and canine	4·3	·110	6·7	·170	...	...	1·4	·035
From summit of occipital crest to alveolus of middle incisives	25·2	·640	29·9	·760	...	...	23·15	·588
From ditto to anterior margin of orbit	...	...	...	...	9·0	·228	10·2	·250
From anterior margin of orbit to alveoli of middle incisive	...	...	...	...	...	...	12·4	·314
Vertical diameter of orbits	...	...	...	...	2·4	·06	2·3	·058
Interval between alveolus of first or deciduous molar and middle incisors	6·8	·170	8·3	·210	...	...	3·8	·096
Width of cranium in rear of the frontal angle	...	...	...	...	3·7	·093	4·4	·112

The Sewalik fossil, noted as No. 1,[1] is a perfect skull, with the exception of the incisive bones, and fortunately exhibits the sutures on the upper surface; a second specimen, consisting of the occipital and parietal regions with the frontal as far forward as the front of the orbits; and a third fragment, consisting of the incisive bones and teeth with the anterior extremity of the nasals and maxillaries, are those from which we draw a comparison of the bones on the upper and lower surface, and of the form and position of the molars.

On the upper surface of the fossil, the chaffron, instead of running in a flat line, slightly concave as in the existing animal, is considerably depressed in the region between the orbits, the superior ridges of which are elevated in proportion, and stand considerably forward on the cranium (Pl. XI. fig. 3). From the remarks on the elongated form of the temporal fossa it may be hardly necessary to advert to the similar extension of the sagittal crest, which is proportionally longer and more marked, with a greater elevation at its junction with the occipital. The broken and fractured boundaries of the nasal aperture in all our specimens of skulls will not admit of our measurements extending to that point, but we are able, from a fragment above referred to, containing the incisive bones and nasal aperture, to note, that the nasal bones are advanced as far forward as those in the living animal, so that a straight line touches their anterior extremities, drawn from the front of the canine alveolus on one side to that on the other. The nasal bones do not expand so much towards the rear as in the existing Hippopotamus, and that part connected with the frontal is more blunt and rounded; the distance between the nasal bone and the orbit and the lachrymal juncture is comparatively larger. The lachrymals descend upon the jugal much the same as in the existing animal, but they appear to advance considerably more forward on the face, the anterior extremity in conjunction with the nasal and maxillary being exactly over the last vicarious molar, whereas that figured by Cuvier represents this point as over the second true molar. The sub-orbitary foramen is also more advanced, and the hollow in which it is situated, formed by the bulge of the jugal and canine alveolus is, as we before remarked, more abrupt. The figure of the muzzle is very similar to the African variety, with a modification in the form of the incisives adapted to the particular form of the teeth (fig. 2). The width of the muzzle is comparatively greater, but the separation of the whole into four bluff swellings with the spaces

[1] No illustrations appeared with the original memoir, but this want was supplied by Messrs Baker and Durand in a short communication published in the same volume of the 'Asiatic Researches.' [Ed.]

intervening for the incisive sutures is a point which has a close resemblance in the existing animal.

The frontal angle is more acute in the fossil; the coronal crest runs more obliquely backwards, and the antero-posterior length of the frontal is twice as much as in the African. From the rounded form of the nasal suture in its contact with this bone, the anterior part of the frontal forms a tongue bounded by the lachrymal in front and by the nasal and orbit on the two sides. From the depth of the temporal fossa, as in the existing animal, the width of the cranium is somewhat less than that of the muzzle over the sub-orbitary foramina, and the interval between the inner side of the zygomatic arch and the surface of the cranium is somewhat less than the width of the cranium.

On the lower surface we are, unfortunately, not so well provided with sutures to guide us in our comparative dimensions; for, with the exception of those between the lines of molars which are in themselves not very distinct, there are none whatever. The position of the bones in rear of the palatal sinus appears to correspond with that of the existing animal, although the relative dimensions and proportions will, it is supposed, be modified by the peculiarities described in the upper surface and dependent on the lengthened form of this region. The basillary mastoid apophyses and the slightly concave surface of the glenoid cavity appear to resemble those of the Cape Hippopotamus; this latter cavity is more in rear of the most salient projection of the zygomatic arches than in the living animal. In the form and position of the molars the only remark that may be made is on the non-parallelism of the lines. Cuvier describes those of the Cape Hippopotamus as parallel but slightly curving outwards towards the front (*un peu ecartées en avant*). We see some difference in our different specimens, but in all there is a curving outwards both in front and rear, the middle of the palate being the most contracted (Pl. XI. fig. 2). This curving outwards is most shown towards the front, where the lines of molars appear to attempt a parallelism with the outer line of the maxillary bone, instead of running parallel to each other. The space between the most advanced molar and the canine is very much smaller in the fossil than in the existing animal, a point that may depend, perhaps, on the substitution of the six small incisors requiring but small alveoli; for the large ones (especially the two central) require a much larger surface and a much greater depth, to admit of their being securely fixed. The palate is, as in the living animal, marked by a deep fissure in front, between the incisive bones; and the suture appears similar, though this is not very distinct in the

DESCRIPTION OF PLATE XII.

HIPPOPOTAMUS (HEXAPROTODON) SIVALENSIS.

Fig. 1. Right side of upper jaw of *Hippopotamus Sivalensis*, showing the three true molars, and the second, third, and fourth premolars, one-half of the natural size. Copied from a drawing by Mr. Ford in Plate LXII., fig. 1, of the Fauna Antiqua Sivalensis. (See page 136.)

Fig. 2. Anterior portion of lower jaw of *Hippopotamus Sivalensis*, showing six horizontal incisors of nearly equal size, two canines, and the anterior premolars, one-fourth of the natural size. Copied from a drawing by Mr. Ford in Plate LXI., fig. 7, of the F. A. S. The specimen is in the British Museum. (See page 136.)

Fig. 3. Another view of same specimen taken from one side, showing the peculiar curve upwards of the canines.

Fig. 4. Descending process of ramus of lower jaw of *Hippopotamus Sivalensis*, one-fourth of the natural size. Copied from a drawing by Mr. Ford in Plate LXI., fig. 9, of the F. A. S. (See page 135.)

Fig. 1.

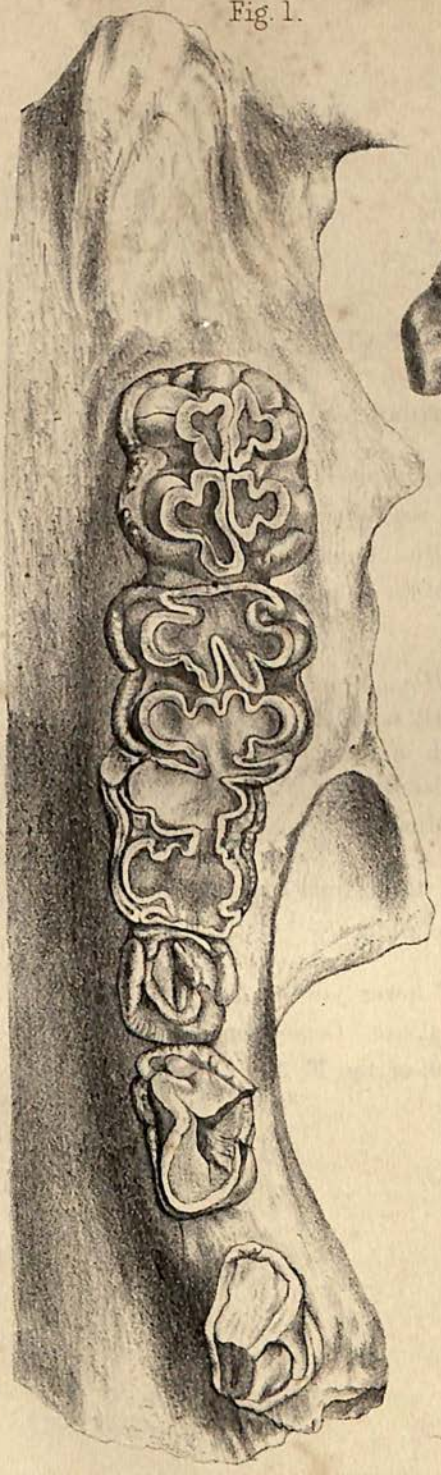


Fig. 2.

Fig. 3.

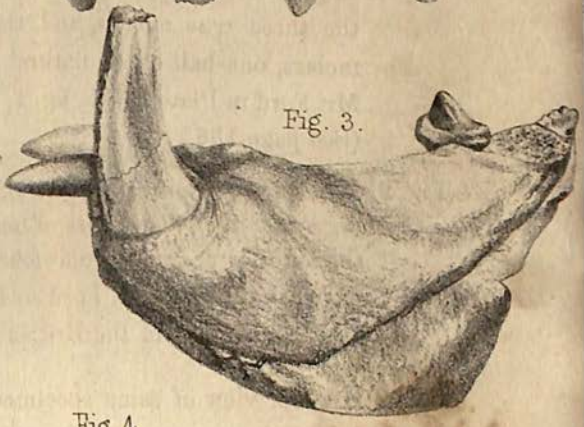
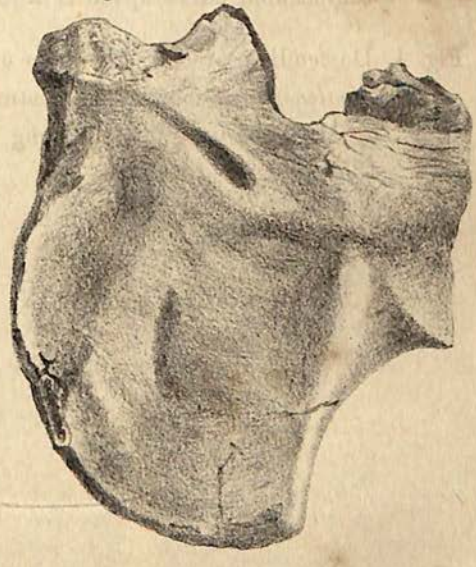


Fig. 4.



G.H. Ford del. J. Dinkel lith.

W. West imp.

Hippopotamus (Hexaprotodon) Sivalensis.

fragment from which we draw our comparisons; the two incisive holes are very distinct, but those referred to by Cuvier as commencing on the edge of the maxillaries in a small channel and terminating on the incisives by another hole, are not so distinctly marked, although it is by no means improbable that in clearing the fossil which is embedded in a hard and crystalline sandstone, the two holes have been made into one; we have before noted the fissure separating the incisive bones, and those (not so strongly marked but equally open outwardly) of the junction between the incisives and maxillaries, or that space between the canine and the third incisive. The extremity of the muzzle in front of the two canines forms part of a circle; if this segment be divided into seven equal parts, and one part given to each echancrure (of which there are three), and two parts to each of the incisive bones containing the alveoli of the incisors, a tolerable idea of the proportions of this region will be obtained. The incisors of the upper jaw, as before remarked, are in diameter smaller than those of the lower; they project but slightly from the alveoli, are directed downwards, and obliquely truncated on their internal faces.

It now merely remains with us to compare the occipital face with that of the African animal, which may be best done by a reference to our table of measurements. We note, however, the great difference in the proportions in breadth to height, which in the latter animal are as 2 to 1, whereas in the Sewalik fossil the proportion is as 3 to 2, showing, as was before remarked, an increased height of the occipital crest. To proceed, therefore, to the lower jaw:—

In comparing the lower jaw with that of the existing animal, independently of the additional incisors, we have a marked difference and distinction in the form of the ramus, the enormous descending process of which is, if anything, more extravagantly developed (Pl. XII. fig. 4). This strange appendage peculiar to the genus, and formed for the attachment of the masseter and temporal muscles, is here of a form less tapering and more deep and massive in its proportions than in the existing animal; the posterior margin is more round and the anterior or that descending from the base of the maxillary bone, which in the existing animal is curved and pointed forwards, is here blunt and unmarked by any peculiarity of form. This angle is inclined outwards, and the outer surface is as depressed for the reception of the muscles as that of the living Hippopotamus. We observe no increase of height in the coronoid process, but it differs from the living animal in not being projected so much forward. There appears to be no difference in the condyles nor in their position with reference

to the form of the jaw; the line of the grinding surface (the specimen from which we draw this description is a lower jaw joined at the symphysis, and only broken at the posterior extremities) is inclined to the outwardly curved direction, described as a peculiarity in the upper surface (Pl. XII. fig. 1): the teeth do not appear to differ from those of the animal now living, but the space between the front molar and the canine is, as in the upper jaw, more contracted (fig. 2). The canines protrude from the alveoli considerably, in a curve slightly inclined backwards at the point (fig. 3), which is obliquely truncated on the internal surface, from the root or point where it leaves the alveolus to the tip. The space for the incisors and the incisive teeth themselves differ, as was before remarked, from those of the existing animal, the large central incisors of which are here replaced by much smaller ones. The number of incisors in the fossil is six, of nearly equal dimensions, cylindrical, inclined outwards at an obtuse angle to the plane of the grinding surface, and sharply truncated at the internal side at the point (fig. 2). In taking the dimensions of the incisive teeth of the upper and lower jaw from two specimens of adult animals we find their proportions as follows:—

	Inches	Mètres
Diameter of incisor—lower jaw	0·9	0·022
Ditto ditto upper jaw	0·7	0·018

If there is any fixed difference in the size of the teeth of each jaw, it exists in the second incisor being a little less than the others. It may be necessary to note here with regard to the number of molars in the lower jaw, that amongst the great number of specimens before us of animals of all ages, we see no mark or vestige of the first milk tooth, or that which, as was mentioned before, falls and is not replaced; and the space between the adjacent molar and the canine is so contracted as hardly to admit of room for another tooth; but as this tooth exists in the upper jaw in every specimen in our possession, we may infer that its non-presence in the lower jaw is accidental.[1] In viewing the lower jaw in profile, we see that the anterior angle below the canines is somewhat more abrupt, and more inclined to the form represented as belonging to the European fossil species; the depth of the inferior maxillary is more regular, and the form of the posterior branches, as before described, very different. The lower surface exhibits a width of symphysis equal to that of the living animal, and the angle formed by the branching off of the two sides is also similar. The width across the muzzle from the exterior side of the canine alveolus to the other is

[1] See Description of Plates in Fauna Antiqua Sivalensis (Pl. lxii. figs. 2 and 3).—[Ed.]

comparatively greater in the Sewalik fossil, and the extreme width of jaw over the penultimate false molar less. It will be seen that these differences of form correspond with those of the skull, the advanced position of the orbit and the contraction of the sinus, in which the infra-orbitary holes are situated, leading to a modification in the whole form of the grinding surface.

Having made the comparison with the Cape and existing Hippopotamus, we will cursorily note the differences that strike us when comparing it with the fossil described by Cuvier as belonging to the cabinet of the Grand Duke of Tuscany, and figured in the first volume of the 'Ossemens Fossiles.' The distinctive differences will be, perhaps, best observed by a reference to the table of measurements; we see, however, that our fossil in the gradual slope of the malar process towards the cheek corresponds, but differs completely in the hollow formed, at this point, between the jugal bone and canine alveolus, which in our fossil is more abrupt and marked. The length of the parietal region of the European fossil is even less than that of the existing animal, and its proportions relatively with the bones of the face less. In the Sewalik fossil the advanced position of the orbit completely modifies the whole form, and, by equalizing the proportions of the anterior and posterior divisions, gives a new style of appearance to the cranium. In the fall of the occipital crest towards the region between the orbits and a consequent height of occipital surface, the Sewalik and Florence fossils agree. In the proportion of the frontal surface to the area of the rest of the skull, the resemblance also holds good; but we have the same difference in the relative position of the canines to the molars; the Florence and African species corresponding in this respect. The grand distinction of the incisives and canines, both in form and number, is peculiar to the *Hippopotamus Sivalensis*. In the lower jaw, the space between the two branches and the angle which is internally formed by them do not resemble those of the Florence fossil, but, as we before remarked, are more assimilated to those of the existing animal, in being round at the angle, and the whole interval space being more open: the descending process of the ramus differs, as explained before; and the form of the anterior angle of the jaw below the canines is somewhat similar and not so gradually rounded off as in the living animal. The difference in size and number of the incisors leads to a difference which, as before noted in the comparison with the living animal, needs not be made the subject of further remark here.

With the *Hippopotamus Sivalensis* and that figured in the

'*Reliquiæ Diluvianæ*,' described as found in a peat bog in Lancashire, and of which a drawing is given in Professor Buckland's work alluded to, little resemblance is recognizable. The Lancashire fossil has the four incisors, with a lower jaw of proportions apparently quite unique, and with a prominency of arch in the nasal bone equally so. We may, however, remark the elevated occipital crest, and the fall towards the space between the orbits which exists in the Lancashire fossil, as this appears to be general in the fossil species, relieving the head from that straightness of chaffron which is noted as one of the peculiarities of the African Hippopotamus.

Having concluded our remarks regarding the *Hippopotamus Sivalensis*, we now come to another and a smaller species of this genus, which appears to have been less numerous, but with the remains of which we are sufficiently provided, although in the possession of only two fragments; one the imperfect skull of an old animal with the teeth much worn, and the other the right side of the lower jaw, showing an unusual contraction or narrowness in the symphysis; this latter fragment contains five molars, the rear one perfect, and the last false molar sufficiently marked to establish the age of the animal; this was past adult, the first and second advanced cylinders of the rear molar being worn, and the third or rear one in the state of germ, but fully out of the alveolus. The form of this tooth differs from the great Hippopotamus in the absence of the trefoil, the wear of the coronals of each pair of collines taking a crescentic form outwards, not unlike that of ruminants,[1] the grinding surface sloping outwards, very similar to the description given by Cuvier of the *Hippopotamus minutus* (Pl. XIII. figs. 1 & 4). The form of the jaw, however, is peculiar, the marked features consisting of a general slenderness of proportions, and an inequality in the depth, which being contracted at the point of the descending process, gets gradually deeper, and diminishes again still more gradually up to the symphysis (Pl. XIII. figs. 1 & 2): in the great Hippopotamus we have a straight, thick, massive jaw. The foramen for the artery distinctly exhibited in the fossil enters just behind the last tooth on the internal face of the ramus, and shows itself

[1] This ruminant character of the teeth afterwards induced Dr. Falconer to constitute this species into a new subgenus, under the designation of Merycopotamus. In a letter to Captain Cautley, dated January 27th, 1844, he writes thus: 'I intend bringing out the Hippo. dissimilis as a new genus, under the name of Merycopotamus, *merico* having reference to the ruminant character of the teeth.' As Merycopotamus the species is figured in the Fauna Antiqua Sivalensis, in Plate lxviii., of which the resemblance between the teeth of Merycopotamus and those of Anthracotherium is pointed out. Subsequently, Dr. Falconer distinguished two species of Merycopotamus. See vol. ii. — [Ed.]

DESCRIPTION OF PLATE XIII.

MERYCOPOTAMUS DISSIMILIS.

Figs. 1 and 2. Palatal and upper surfaces of a cranium, in the British Museum, of *Merycopotamus dissimilis*, one-third of the natural size. Copied from drawings by Mr. Ford in Plate LXVII., figs. 3 and 3 *b*, of the Fauna Antiqua Sivalensis. (See pages 138 & 506.)

Figs. 3 and 4. Lower jaw, right side, seen in plan and profile, of *Merycopotamus dissimilis*, one-third of the natural size. Copied from drawings by Mr. Ford in the F. A. S., Plate LXVII., figs. 4 and 4 *a*. The specimen is in the British Museum. (See pages 138 & 506.)

[In page 138 it will be noted that the figures are not correctly numbered.]

Fig. 1.

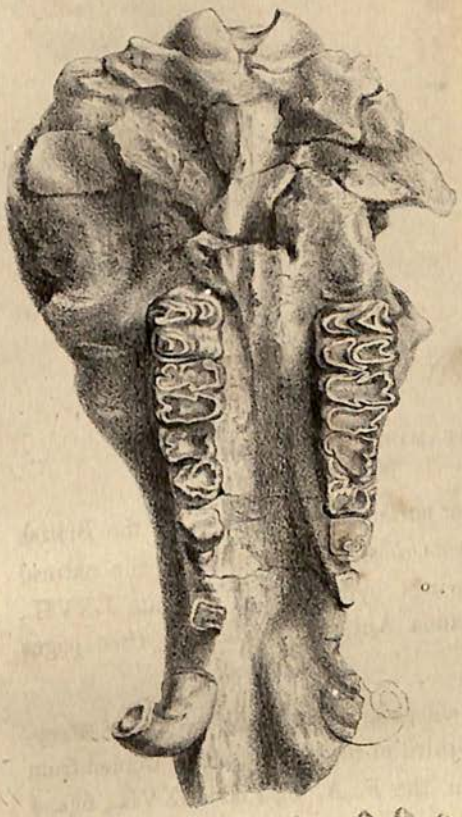


Fig. 2.

Fig. 3.

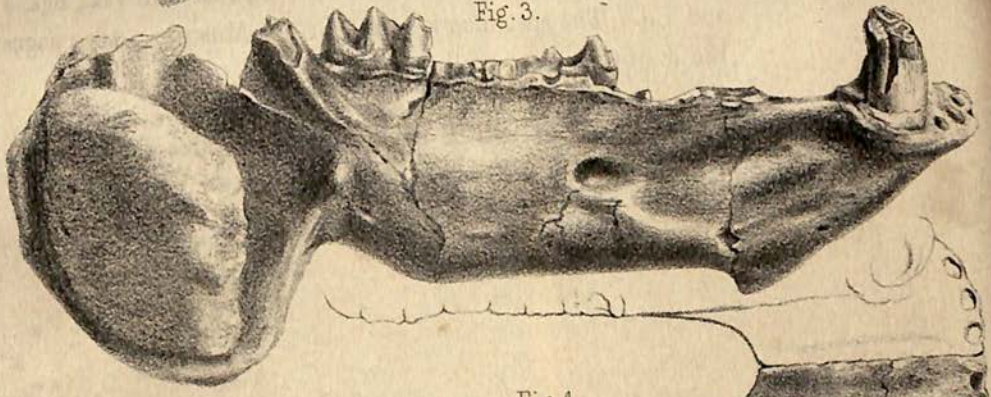


Fig. 4.

G.H. Ford del. J. Dinkel lith.

W. West imp.

Merycopotamus dissimilis.

again on the opposite side just between and under the fourth and fifth molar, in a markedly large hole from which, to the space between the tusk and the most advanced molar, there is a deep channel or indentation running upwards in a curved line parallel to the lower face of the jaw. The anterior and posterior portions of this beautiful fragment are unfortunately wanting, but a small part of the symphysis, at which point the fossil terminates, is distinctly marked, as well as the transverse section of the canine or tusk which, as in the large animal, is pear-shaped. A considerable portion of the anterior extremity is wanting, and with the tusk the fracture shows only one alveolus or hollow for an incisive tooth; the existence of two, however, can hardly be doubted, but the narrowness of the front may make a greater number than four between the two canines problematical.[1] The ramus of this specimen is strongly marked on its anterior part by an elevated ridge pointing angularly forwards, and pushing forward a nearly flat surface to the centre of the rear tooth; the descending process is unfortunately too much broken to allow of our speaking decidedly, but the angle of departure from the straight line of the jaw is abrupt (Pl. XIII. fig. 3). The other remains of this smaller species to which we have alluded consist of a skull, the front and rear of which is broken off, and one line of molars with the palate only perfect. The superimposed cranium would appear to be contorted by pressure, as is by no means uncommon, but this circumstance would lead us to refrain from an attempt at characterizing its peculiarities. The molars consist of the three rear permanent ones, and the last false molar, this latter one exhibiting the crescentic form of wear on its coronal surface, described as peculiar to the first fragment. The other molars are much worn, and, therefore, with the exception of the encircling ridge of enamel, we have not those flexures which would have brought us to a correct conclusion. These molars are remarkably broad in proportion to their antero-posterior dimensions, and have an oblique grinding surface, as before described in the other fragment. We may remark, that, should these two remains belong to a small Hippopotamus of the same species, the great difference in the breadth of the grinding surface in the upper and lower jaws, as marked as it is in the Rhinoceros, would establish a species with (in this respect) rather unusual peculiarities. To this smaller species we propose the name of *dissimilis*, from the differences of form from the rest of the genus.

From the above additions to the species of the Hippo-

[1] Subsequent specimens showed that there were six incisors. See Plate xiii. fig. 4.—[Ed.]

potamus, and from the marked distinctions in the incisive apparatus of the *Hippopotamus Sivalensis*, we shall, perhaps, be justified in at once establishing a new subgenus in this genus of mammalia, fixing the subgeneric characters on the incisive teeth. So marked a distinction in the form, number, and character of the incisors, will, we imagine, admit of such an arrangement, with every advantage to science, and in taking this step we place the new subgenus in the following position and order [1]:—

Genus—HIPPOPOTAMUS.

1st Subgenus—HEXAPROTODON.

1. Species—*H. Sivalensis* (Nobis).
2. Species—*H. dissimilis* (Nob.). An hìc, vel infrà, potius referendus?

2nd Subgenus—TETRAPROTODON.

1. Species—*H. amphibius*. Recent.
2. Species—*H. antiquus* (Cuv.). Fossil.
3. Species—*H. minor* (Cuv.). Fossil.
4. Species—*H. medius* (Cuv.). Fossil.
5. Species—*H. minimus* (Cuv.). Fossil.

The specific characters of the first species of our new subgenus are as follows :—

Genus—HIPPOPOTAMUS.

Subgenus—HEXAPROTODON.

Species—*Sivalensis*.

CHAR.—H. dentibus primoribus utrinque sex, subæqualibus; laniariis difformibus: superioribus nempe quoad sectionem transversalem reniformibus: inferioribus pyriformibus; cranio elongato; oculo ad medium caput ferè attingente; facie ad latera valdè sinuatâ.

Before closing this paper, we may make a few general remarks on the remains of this genus, which, with the exception of the Mastodons and Elephants, are by far the most numerous.

As may be imagined in such an extensive collection we find the remains of animals of all ages, with teeth in every variety and state of detrition; from the young animal with the complicated and triple cylindered milk tooth, to the old and worn down molar without any mark of the trefoil, and with a simple encircling ridge of enamel. In the fossil skull described as approaching adult (from which the measurements noted as No. 1 have been taken) we have a beautiful exhibition of the teeth in that state when the animal has just lost its last milk tooth, and the new molar or '*dent de remplacement*' is just showing itself in germ, whilst the last permanent molar,

[1] See *antea*, page 21; also Synopsis of Hippopotami in vol. ii.—[ED.]

or that most posterior, is in the same state of advancement, having just pierced the bone: the oldest tooth in the head or the first permanent molar is just worn to that state when the development of the trefoil crown is most perfect; the second permanent molar is just showing this appearance on its two front pillars; the front false or pointed molars are unworn, and exhibit in all their perfection the richly embossed surface, which is peculiar to these teeth in the Hippopotami. The first false molar or milk tooth seems to have retained its position in many of our fossils, long after the fall of the other milk teeth, and long after the arrival of the animal at the adult state. In some of our skulls, which are the remains of very old animals, we observe the alveolus of this tooth very distinct, and having the appearance more of having been broken off in the fossil than of having been lost previous to the death of the animal, in which case, moreover, a filling in of the pit from the growth of the bone would be more or less evident in the fossil. From the natural wear of the tusks upon each other, the truncated extremity of the upper one, which in the *Hippopotamus Sivalensis* is described as reniform, occurs on the convex or outer side of the tusk; and this must be the case wherever the tusk belongs to the upper jaw. Amongst a very extensive and very large collection, containing, as we before remarked, three perfect skulls, with a number of fragments of nearly perfect lower jaws, with a great number of pieces of both more or less mutilated, the reniform tusk is an invariable appendage to the upper, and the pyriform to the lower jaw. Our collection, however, exhibits one solitary instance of the anterior extremity of a reniform tusk truncated on the inner or concave surface; this, unfortunately, is a separate fragment, unattached to any portion of the jaw, and bearing in itself no further mark of its having existed in the *lower* jaw than this truncation of the extremity. It is difficult to imagine any fortuitous circumstance that would have produced such an anomaly, and it is at the same time difficult to come to a conclusion contrary to the facts elicited by such an extensive collection of remains, in which we see no sign of the reniform character of the canine in the lower jaw; should the truncation alluded to *not* be accidental, or be caused by some deformity in the position in the alveolus, we have yet to discover a variety of the Hippopotamus with the reniform tusk in the lower jaw. The fact of the existence of this fragment, however, may be as well noted, as we observe peculiarities of form in other fragments of the bones of the head that may ultimately prove to belong to different species. We have contented ourselves with drawing our comparisons from the bones of the head,

without any reference to the osseous structure generally of the animal, in which our collections, however, abound, especially in vertebræ and the solid articulating extremities of the bones. A more lengthened period of search and examination will add much to the value of an inquiry upon this point, and a comparison with the actual bones of the Cape Hippopotamus, instead of Cuvier's drawings, will render any attempt at a discrimination of existing differences easier, and when completed and worked out, doubly valuable.

NORTHERN DOAB: *Nov.* 15, 1835.

APPENDIX TO MEMOIR ON HIPPOPOTAMUS.

I.—DESCRIPTIONS BY DR. FALCONER OF SPECIMENS OF FOSSIL HIPPOPOTAMUS IN THE MUSEUM OF THE ASIATIC SOCIETY OF BENGAL.

A. Specimens of Hippopotamus (Hexaprotodon) Iravaticus, from Burmah.

No. 303.—Lower end of left radius detached from the shaft and ulnar extremity broken off; of small size, and corresponding very closely with the specimen figured in the 'Fauna Antiqua Sivalensis,' Pl. LXV. fig. 18. This specimen is notable as being one of the very few referable to Hippopotamus contained in the Ava collection.

Supposed to have come from Ava, from the ferruginous matrix, and from differing from the Sewalik species.

No. 307.—Lower end of left femur, showing the articulating condyles and a part of the shaft—both much weathered and the surface abraded, so as to render the character indistinct. The bone is proportionally of much smaller size than *Hippopotamus Sivalensis*, and would thus agree with the dimensions of the radius No. 303, and with specimens assigned to *Hippopotamus Iravaticus* in the 'Fauna Antiq. Sival.' The shaft is slender.

The specimen is believed to have come from Ava, being black from iron infiltration, and very heavy.

B. Specimens of Hippopotamus (Hexaprotodon) Sivalensis. Mostly from the Sewalik Hills.

No. 193.—A nearly entire cranium, in three pieces, showing the occiput and occipital crest, the sagittal do., and the whole of the chevron region on to the border of the incisives. Both zygomatic arches broken off, and the rim of both orbits damaged. These parts show marks of recent fracture, and were probably perfect when presented. The true molars of both sides broken off. The four premolars on the left side are present, and the three posterior premolars on the right side nearly entire, and with the crowns much worn, showing the animal to have been old. A section of the right canine is also seen *in situ*. This is, on the whole, a very perfect specimen—nearly as much so as fig. 1, Pl. LIX. of 'Faun. Antiq. Siv.' This subdivision of the genus is distinguished by the length of the sagittal crest and the slight projection of

the orbits above the plain of the frontal; both of which characters are well shown when the skull is compared with *Hipp. Palæindicus*. 'Nerbudda Cat.,' No. 17. The specimen is partly covered with hard sandstone matrix. No mark, but inferred to be Sewalik, and probably from Col. Colvin.

No. 194.—Cranium broken across near the constriction in front of the orbits, but very perfect behind, showing the zygomatic arches, temporal fossæ, occiput, and condyles; the orbits a little broken in their rim; molar teeth protruded, but broken off. This must have belonged to an animal of large size, as the distance between the outer surface of the zygomatic arches is 13·7 inches. No mark or number, but embedded in hard sandstone, and inferred to belong to the species, from the length of the sagittal suture and the little prominence of the orbits above the plain of the frontal. Inferred to be Sewalik.

No. 196.—Like the last. Occipital portion more perfect, with edge of crest preserved. The sagittal crest and both zygomatic arches broken off. Right orbit a little mutilated behind, but showing a large lachrymal tuberosity. Left orbit nearly entire behind, showing the whole of the rim. Four molars on the right side in the last stage of detrition, showing the animal to have been extremely old. Covered with sandstone matrix.

No. 197.—Another, like the last; mutilated in front of orbits, but showing the tympanic fossæ. The last true molar on either side is not much emerged above the alveolus, and the sutures are open, showing the animal to have been young. This specimen is more mutilated about the orbits than the three preceding, and the temporal fossæ are filled with hard sandstone matrix.

No. 198.—Another cranium, nearly like 194, with two zygomatic arches and orbits. The last true molar on each side emerged but unworn. All the cavities filled with hard sandstone matrix. A young adult.

No. 199.—Cranium mutilated at the muzzle in front of the second premolar, and with the parietals and occiput obliquely broken off towards the left side, so as to expose the cerebral cavity. Right zygomatic arch and glenoid surface entire; orbits a little damaged in the rim; nasal bones stove in by pressure. The teeth on either side are all present, except the anterior premolar. The last true molar is in a state of germ; the penultimate shows well the basal cingulum of enamel. The animal was a young adult. The cavities and fossæ are filled up with a hard gritty sandstone. This specimen shows the characters of the upper molars better than any of the five preceding specimens (194 to 198).

No. 200.—Mutilated cranium, broken off behind, about the middle of the temporal fossæ, and in front, through the first true molar. Zygomatic arch present on the right side, with the greater portion of both orbits. The three last molars on the left side present, and the two last on the left; the former well worn, showing the animal to have been old. Hard sandstone filling the cavities and fossæ.

No. 201.—Fine fragment of the muzzle, broken off a little behind the fossæ of the canine alveoli, showing on the right side three premolars, well worn. The whole tuberosity of the canine alveolus on the left side, together with the empty alveoli of three incisors, are present; both broken off on the right side. Belonged to an old animal. An instructive specimen, as showing the characters of the canines and incisors of the upper jaw. Hard sandstone matrix.

No. 202.—Mutilated fragment of cranium, broken off from behind the right orbit, obliquely forwards to in front of left orbit and anteriorly about the middle of the muzzle constriction, showing on the right side the crowns of the back molars, well worn and in tolerable preservation. Belonged to an old animal. Hard sandstone matrix. No. 201 and No. 202 unite, and belong to one cranium.

No. 203.—Fragment of cranium, comprising the upper maxilla of both sides, broken off on a level with the floor of the nasal fossa, showing on either side the six back molars, very much worn, proving the animal to have been very old. From Ava.(?)

No. 204.—Fragment of upper maxilla, left side, showing the two last premolars and three true molars *in situ*; the last molar is a little worn, showing the characteristic trefoil discs of wear. Half of palate also shown. Some ferruginous coloured matrix on the palate like the Ava specimens.

No. 205.—Superior maxilla, right side, containing the five posterior teeth *in situ* of a very old animal. Specimen much mutilated.

No. 206.—Fine specimen of the cranium, broken off in front about the middle of the facial portion, showing the occiput nearly entire, as also the prominent edge of the occipital and sagittal crests; the two zygomatic arches and temporal fossæ, together with both orbits, the right nearly entire: the teeth all broken off, and the spheno-palatine region with occipital condyles wholly abraded by attrition. Hard sandstone matrix in the temporal fossæ and orbits, the most perfect specimen in the collection, so far as regards the strictly cranial characters of the head.

No. 207.—Fine specimen comprising the greater part of the lower jaw, both sides, in two pieces. The left ramus containing all the molars, except the anterior premolar, which had dropped out; the right containing the anterior premolar and the next five teeth, the last true molar alone being wanting. The chin portion is perfect to the border of the incisive alveoli. The two canines are present, broken off only at their tips, and presenting the discs of wear on their posterior surface. The six incisors are also present, perfect nearly to their tips; they emerge nearly horizontally, the outer being a little lower, and they are subequal in size. The left ramus shows the last three true molars, of which the anterior is much worn, the penultimate less so, and the last barely touched; the premolars are all broken off, except one. On the right side the base of the anterior premolar is *in situ*, with but a very short interval between it and the canine, not much exceeding that between it and the second premolar; the body of this tooth is broken

off, as are also the second and third premolars. The fourth is present and barely touched at its apex, showing that the animal was adult, but not old. This specimen is probably the most perfect that has been found in the Sewalik hills, being deficient only in the ascending ramus and the expanding disc at its base. The difference in the length of the diastema between it and *H. amphibius* is very remarkable. Probably a female. This specimen (from Conductor Dawe's Collection) was very perfect and valuable, but it has been hardly dealt with in the Asiatic Museum, most of the teeth having been broken off, and the fragments searched for everywhere in vain.

No. 208.—Exserted portion of the upper canine right side, showing the disc of wear complete nearly to the tip.

No. 209.—Inferior maxilla with the symphysial portion perfect on both sides on the border of the incisive alveoli, showing part of the canines *in situ* and the outer incisor on either side, the four intermediate ones having dropped out; the left horizontal ramus exhibiting the broken off bodies of seven molars, the right side being shorter and showing only the four premolars, also broken off. The alveoli of the four middle incisors are much larger in diameter than in specimen No. 207, indicating probably that the animal was a male.

No. 210.—Mutilated fragment of lower jaw, comprising only the symphysial part and a short portion of the right ramus; the canine alveoli on either side broken off; the two middle incisors very large, being 1·25 inch in diameter. The alveoli of the next two incisors show them to have been not more than half this diameter: the outermost on each side nearly as large as the middle ones; probably an old large sized male. The premolars very much worn. This specimen is much weathered and greyish white in colour, although thoroughly mineralized and heavy. It differs very considerably in the large size of the middle incisors from any other specimen in the collection, but there is no mark or label to indicate whether it is from Ava or the Sewalik hills.

No. 212.—Lower jaw, right side, comprising the posterior half of horizontal ramus, containing the last three molars, also the ascending ramus with the coronoid process and condyle, nearly entire: the leafy expansion below broken off; the last true molar shows a well-developed talon behind: attached to sandstone matrix.

No. 214.—Fragment comprising the lower jaw, both sides, at the symphysis, showing the canines and six incisors; at other parts much mutilated; belonged to a young or half-grown animal, with milk dentition? No mark or number. Can this be the Ava specimen from Col. Burney.—*Journ. As. Soc.* vol. vi. p. 1009?

No. 230.—Detached fragment upper maxilla, right side, containing the alveoli of a canine and three incisors, and the three anterior premolars broken off: the greater part of the canine is seen in the alveolus.

No. 231.—Axis with odontoid process, broken off.

No. 232.—Right femur, upper portion, comprising head and trochanters.

No. 235.—Lower jaw, right side, posterior half with portion of ascending ramus and leafy expansion, also the last three molars. Very black and heavy. Doubtful if from Sewalik hills or Ava.

No. 237.—Lower end of united radius and ulna, right side.

No. 239.—Lower end of radius and ulna, right side, considerably smaller than No. 237.

No. 240.—Upper end of femur, left side, top of trochanter broken off.

No. 241.—Patella very entire.

No. 244.—Astragalus.

No. 710.—Sixth cervical vertebra, nearly perfect, of a young adult, the posterior articular epiphyses not being synostosed: the neural arch and both superior transverse processes together with both vertebral canals present: the latter are very short.

No. 711.—Another sixth cervical vertebra of an older animal, and tolerably perfect: vertebral canal very short.

No. 712.—Dorsal vertebra nearly entire, with a considerable portion of the spinous apophysis resembling fig. 3 of Pl. LXIV. of the Faun. Antiq. Sivalensis.

C. Specimens of Merycopotamus dissimilis, from the Sewalik Hills.

No. 246.—Lower jaw, right side, comprising the horizontal ramus and part of the ascending ramus; the expanded disc below lost by a recent fracture; contains the last three molars *in situ*, and little worn. The three premolars dropped out, but their alveoli shown. The canine also *in situ*. The two last teeth exhibit well the rugous surface of the enamel, with the basal cingulum and the ruminant-like pattern of wear on the crown, which are characteristic of the genus, which is nearly allied to *Anthracotherium* in the teeth.[1]

No. 247.—Fragment, comprising the posterior part of the ramus, left side, containing the three last molars *in situ*, but very much concealed by matrix. Of a larger size than No. 246.

D. Specimens of Hippopotamus (Tetraprotodon) Palæindicus; from the Nerbudda.

No. 16.—Specimen comprising the entire cranium, truncated anteriorly about the middle of the nasals; containing three back molars on each side, and on the left side the alveolus of the last premolar.

[1] See Journ. As. Soc. vol. vi. p. 899, and vol. v. p. 293. The entire specimen, as presented to the As. Soc. Museum, is figured in the Fauna Antiq. Sival. Plate lxvii. fig. 6. The most characteristic part of it has been subsequently lost.

Occiput, occipital and sagittal crests, zygomatic arches and orbits nearly entire; also the glenoid articulating surfaces perfect; occipital condyles broken off. Teeth: the two anterior true molars worn, and showing the pattern characteristic of the species; the last molar in germ, and not protruded through the gums, indicating a young adult animal; nasals raised above the plane of the front, at the naso-frontal suture. An exceedingly fine specimen, more perfect than the original specimen upon which was founded the species as figured in Faun. Antiq. Siv., Pl. LVII., fig. 1, and Pl. LVIII., fig. 4. It shows well the great saliency of the occipital and sagittal crests, and the projection of the orbits above the plane of the frontal.

No. 17.—Short fragment, comprising the chin portion of the lower jaw, both sides, near the anterior extremity of the symphysis, containing the alveoli in half section of *four* incisors and two canines. Diameter of central incisors, 1·5 in.; of the external incisors, 1·85 in. The true character of the specimen was recognized by Dr. Spilsbury. This is a very valuable specimen, as it conclusively refutes the opinion put forward by De Blainville (liv. xxii., 'Hippopotamus,' page 240), that the Nerbudda *Tetraprotodon* is identical with the living African species, the middle incisors being the largest in the latter, while the converse holds in the former; and the relative proportion of the incisors differs very remarkably.[1]

II.—Note upon a Young Skull of Merycopotamus dissimilis, from Burmah. Brought by Professor Oldham.

(*Note-Book*, 28*th Aug.* 1862.)

The skull is of an adolescent animal, with all the sutures open: penultimate, antepenultimate (1st and 2nd m.) in place, present on right side, crown broken, and p.m. 4 just emerging; also p.m. 3 emerging; other teeth broken off or covered by matrix on right side; on left, only part (inner) of t.m. 1 and 2 seen—the rest in front all hammered off; the dilated part of muzzle (inside portion) also broken off. Matrix of very hard and compact sandstone. Fossil dark reddish brown. (See Pl. XV. figs. 1 and 2.)

Cerebral boîte broken off. Cavity of anterior lobe of cerebrum seen below (fig. 1 *a*), quite clean; occipital and parietal portion broken off, with the whole of temporal and parietal regions and zygomatic. Frontals *b b'* broken above; behind, the orbits send down a process on either side between lachrymals and nasals; one concave mass between orbits, but upper edge of rim of orbits broken on both sides, so that extent of concavity concealed. Orbits evidently of large size, but rim partly broken on both sides. (Frontal and orbits hippopotamine.) A foramen on either side at middle of frontals at (*c c*).

Lachrymal *e e* most perfect on right side, of a narrow oblong, let in between frontal apophyses and nasal above and maxillary below. Length, 1·2 in.; width, 4·5 in. Nasals, broad at base (*d d*), contract into a narrow muzzle forwards. Suture with maxillary bone very open on right side (marked by white band, *f*). *g g*, maxillaries long; extremities or

[1] Another species of Hippopotamus from the valley of the Nerbudda, with *six* incisors, *Hexa-protodon Namadicus* (Falc. and Cautl.), is figured in the Fauna Antiqua Sivalensis. See Plate lviii. fig. 1, &c.—[Ed.]

nasal aperture not seen, and incisives broken off. Infra-orbital foramen large, and about middle of height of muzzle, situated right above the interval between p.m. 4 and 3. Palate long, but character not seen. Surface of enamel very rugous.

Dimensions.

Width of nasals at base	1·9
Extreme length of fragment	7·5
Greatest contraction of muzzle	1.2
Length of two (2 and 3) true molars	1·9
Ditto of two last premolars	about 1·3

Last premolar consists of a single *barrel*, with one pyramidal cusp in front, and another behind.

V. DESCRIPTION OF A FRAGMENT OF A JAW OF AN UNKNOWN EXTINCT PACHYDERMATOUS ANIMAL FROM THE VALLEY OF THE MURKUNDA.[1]

BY H. FALCONER, M.D.

The fossil is a portion of the right side of the upper jaw, containing the two posterior molars. The last tooth is nearly entire, and very perfect; the other is broken off at its anterior third. The teeth are not mineralized. The enamel retains its light and pearly colour; but the osseous structure

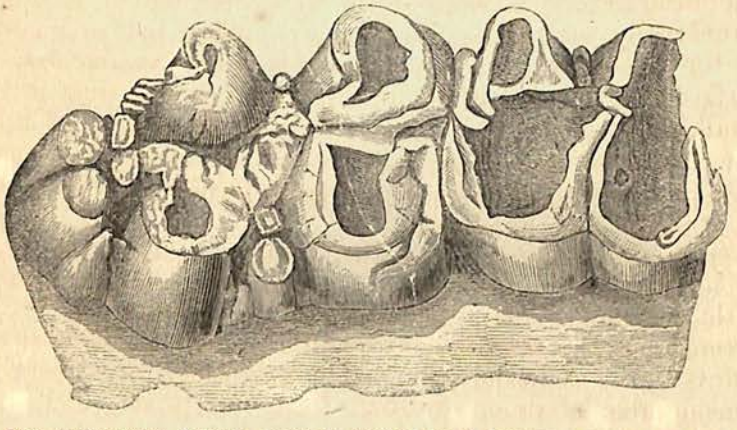
[1] The specimen to which this memoir refers was found by Messrs. Baker and Durand in the tertiary hills between the Murkunda Pass and Pinjore, and was figured by them in the 'Asiatic Researches' (vol. xix. plate v. figs. 2 *a*, 2 *b*, and 2 *d*), with the following description: 'The specimen is the only one of the kind hitherto met with. It is a fragment from the jaw of some pachydermatous animal, but differs materially from all with which it has been compared. Further discoveries will, it is hoped, throw light on this interesting fragment.' To this description, the following note by Mr. James Prinsep, the editor of the 'As. Researches,' is appended:—'The drawing of this fragment so much resembled Cuvier's plates of the hippopotamus, that I wondered at the authors' misgivings on the subject, and wrote to interrogate Dr. Falconer previous to putting the present page to press. Dr. F., however, assures me that the fragment undoubtedly does not belong to that animal; but, as Lieuts. Baker and Durand had rightly conjectured, to a new pachydermatous animal, to which Capt. Cautley and himself have from other specimens given the name of *Chœrotherium*; "the engraving is imperfect, and so much like the hippopotamus that it might easily be mistaken. The difference in the original tooth, however, is well marked. There is no real trefoil on it; the appearance is spurious; the plane of wearing is oblique; the spur is strongly bifid; and the collines, or mammillary processes, are wide apart."—J. P.' In another paper on Sewalik fossils, published by Messrs. Baker and Durand, in the Journ. Asiat. Soc. for May 1836 (vol. v. p. 293), the opinion is expressed that the *Chœrotherium* of Falconer 'is a new species of *Anthracotherium*, a view which, in the following memoir, Dr. F. opposes. In a manuscript 'Synopsis of Fossils from the Sewalik Hills,' by Dr. F., I find the following:—'*Tetraconodon* (or *Chœrotherium*) *grandis*, Nobis, Dadoopoor collection.' There can be no doubt, then, that the fossil described as *Tetraconodon* was the same as *Chœrotherium*, and this opinion is now corroborated by Sir Proby Cautley, who has a perfect remembrance of the specimen, and has carefully perused the memoir. It is somewhat surprising that this memoir, which was probably written about the year 1835, was never published, and that the fossil is not figured in the Fauna Antiqua Sivalensis. In a letter, however, written by Dr. Falconer to Capt. Cautley, in January 1844, I find the following:—'We must have a *Chœrotherium*, for Agassiz quotes it under our authority in his "Nomenclator Zoologicus."' The figure is taken from a drawing by a native artist, labelled 'The Dadoopoor Tooth,' and found among Dr. Falconer's papers. What has become of the fossil, I have been unable to ascertain.—[Ed.]

of the jaw and alveoli has disappeared, and given place to an argillaceo-calcareous incrustation of a pale yellow colour, which also fills the discs of detrition of the grinding surface.

The teeth had belonged to an adult animal; the posterior molar having come into use, and the anterior one being considerably worn down. They are known to be the two last molars, from the posterior one having the accessory spur or process which characterizes this tooth. Their form and state of detrition show that they were not the last and penultimate milk molars.

They have the figure of a rectangular or nearly square shaft, rounded at the corners, surmounted by a crown divided into four large conical or mastoid processes brought together in transverse pairs. The body of the tooth on either side is contracted in the middle by a perpendicular fossa down to the root, dividing it into two portions, each of which has a rounded or convex surface; so that altogether the tooth has the appearance of four cylinders in apposition by pairs, terminating in a crown of as many conical processes.

FIG. 5.



THE DADOOPOOR TOOTH, FROM A SKETCH BY A NATIVE ARTIST; OF THE NATURAL SIZE.

There is no bulge or ridge of enamel making the circuit of the shaft, so as to form a neck or *collet*; but the crown is complicated by small transverse ridges of enamel, one at each end of the tooth, and a third in the angle of junction of the pairs; these are chiefly developed along the outer colliculi, and are more or less complete forwards.

The plane of detrition is oblique, the teeth sloping at a considerable angle from their outer margin inwards; so that the colliculi of the inner lines are truncated, while the outer remain more or less conical.

The external outline of the crown viewed in profile gives a sweep of salient and re-entering angles getting more and more obsolete forwards, from advanced detrition, with a small prominence in the open angles or swell in the colliculi, marking the commencement of the transverse ridges.

The vertical outline externally of the outer colliculi, from the root to the apex, is but slightly convex.

Besides the complication of the spur in the last tooth there are other differences between the two, dependent on form and detrition.

To begin with the last, which is the more perfect and least worn :—

This tooth, exclusive of the spur, is a little longer than broad; and the distinction of the crown into two pairs of processes, and of each pair into separate colliculi, is well marked.

The two outer processes have the same form, differing only from wearing, the posterior being more pointed, and their outer surface rises to the apex with little of a curve; they are flattened laterally, sloping right and left. Their inner surface inclines from the point, downwards, at a considerable angle; the anterior one is worn down to a disc, which is oblong transversely, and surrounded by a complete belt of enamel; in the posterior one, the enamel is scarcely touched, the surface is marked with slight inequalities, the disc is very small, and the posterior edge of the process is notched into a few tubercles. Around the base, at their connected aspect, both processes are bounded by a fissure, which separates them from the rest of the crown.

In the angle between these colliculi lies the middle transverse crest or ridge of enamel. It is notched, narrow, and little prominent. It arises by a slender pillar in the external fossa, where the shaft is contracted, runs forward a short way, and is then lost in detrition. The posterior crest arises in a considerable lobule or swelling of the hind process at its base. It is well notched, and runs forward in a sweep between the process and the spur, terminating at the outer third of the latter. The anterior ridge arises also in a swelling of the corresponding process. It is partly worn and has a flattish surface. It stretches across (with an accidental breach of continuity in the fossil) along the margin of the crown, and descends in a curve, so as to turn round a little way on the shaft.

Now, in description of the inner divisions:—The protuberance of the colliculi has disappeared; they are truncated from wearing down to a flat disc. The corresponding portions of the shaft, from which the processes rise, are more

convex than those of the outer side, having also a swell vertically. The anterior one has the form of a cylinder compressed on the sides; it is more worn than the hind one. Its disc is transversely oblong, surrounded by a belt of enamel, which at its outer anterior angle runs into the corresponding transverse crest (there is an accidental fissure in the enamel here), so that in the continuation of the latter it appears to double back on itself, descending in a sweep upon the middle of the cylinder, where it terminates obtusely at the upper third of it, forming a marked feature in the tooth.

The posterior division is more irregular in the outline of its crown; the disc of detrition is less; the cincture of enamel is wider and at its anterior outer angle projects in a broad surface into the hollow between the outer processes, throwing out also a heel in the opposite direction into the fossa between the inner divisions. Posteriorly it is notched by an angular fissure into a sort of cordiform outline, with the appearance of an additional pillar joined on to it opposite the clefts of the spur.

In the fossa of contraction between the divisions there arises a considerable pillar of enamel, tuberculated laterally.

The spur is a large convex bifid process, like two convex cones in apposition, increased laterally by tubercles. The apices formed by the cleft are circular and a little worn.

The anterior or penultimate molar has the same general form as the last one, but it is more simple, and its dimensions are somewhat less. It is less deeply contracted in the middle, and the outline of the divisions of the shaft is less convex. Its crown is much more worn. The anterior half is mutilated by a fracture across, at a third of its length, and the pair of processes have been worn down to one continuous transverse disc. The posterior half has the divisions still distinct. The outer hillock resembles the adjoining one of the last tooth; its disc is oblique, transversely oblong, and encircled with an entire belt of enamel. The inner division has none of the complexity of the corresponding portion of the last tooth. It has a simple broadly-oblong outline and disc. Its belt of enamel in the middle of the crown is confused with the adjoining one of the anterior half. There is no accessory pillar of enamel in the fossa between the inner divisions, as in the last tooth.

The middle transverse crest is seen in the furrow between the outer hillocks, advancing but a short way forwards. The posterior one is also present, its surface flattened by wearing. The mutilation of the tooth anteriorly leaves it doubtful whether the anterior crest was present, or not,

and whether it swept round on the inner side of the shaft, as in the last molar.

The length of the tooth is greater on the coronal surface than at the base of the shaft.

The dimensions of the fossil are as follows :—

	Inches
Length of the fragment	3·38
Ditto of the last molar	2·05
Ditto ditto excluding the spur	1·68
Width of ditto (greatest)	1·48
Height of the outer hillocks of ditto (greatest posterior)	·75
Ditto of the inner side ditto	·75
Length of the anterior molar	1·2
Width of ditto	1·3
Anterior width of hind molar, top of coronal	1·2

Now to determine the animal to which the teeth belonged.

The fragment is a unique specimen in a large collection of fossil bones, got within the last few months in the valley of the Murkunda and other small adjoining valleys, from the upper deposit of the tertiary line of hills, west of the Jumna, forming the flank of the Himalayahs. Of heads and jaws alone we have upwards of 300 fragments, more or less perfect, of three species of Hippopotamus, two of which are ascertained to be distinct, and a third doubtful; as many of the *Mastodon Elephantoïdes* and fossil Elephant respectively; several of a Rhinoceros; of Hogs, of a great variety of Ruminants, and of some other animals. The fragments of other bones amount to several thousands. This will give an idea of the richness of the collection, yet among the whole there is no other specimen with teeth resembling that now described. There are, therefore, at present, but the two molars to go upon; but these are sufficiently well marked to discriminate the animal.

That the fossil belonged to an herbivorous animal of the family Pachydermata is at once evident from the form and detrition of the teeth.

The subdivisions of the family, dependent on dentition, give further aid in making it out. From all Pachydermata, which have transverse or flexuous lines, or crescentic plates of enamel in the teeth, such as the Horse, Rhinoceros, Anoplotherium, Palæotherium, &c., it is distinguished by the division of the coronal into four hillocks or tuberosities.

The comparison is, therefore, reduced to those genera which have rounded prominences on the back molars.

Of these it differs from the Tapir and Lophiodon in the prominences not being in the transverse crests, which form so distinctive a character of these genera.

It differs from the existing Hog tribe and the Chœropotamus, in the coronal not being an aggregation of tubercles or rounded cylinders, but divided into four distinct portions, two of which[1] are certainly conical.

At first sight the fragment has a considerable resemblance to certain species of Mastodon, in the form of the protuberances and discs of detrition, such as the *M. Andium*; but the nearly square form of the shaft, the presence of only two pairs of hillocks in a back grinder on a coronal along with a spur, and another tooth of nearly the same form placed before it, are proofs of molars in a series of several, and alone sufficient to distinguish it from every species of that genus.

The Anthracotherium has a coronal divided into four distinct pyramidal hillocks, with deep furrows between. In these respects there is some resemblance in our fossil. But the two differ materially. In the Anthracotherium the shaft has a ridge or collar of enamel in relief around it; and it is strongly convex in its vertical section. The hillocks are a little elevated, and their sides converge rapidly in a blunt pyramid; the surfaces by which these pyramids regard each other throw off connecting sharp and sometimes bifurcating edges, which make the coronal angular. Further, the upper molars have four accessory tubercles, projecting from the collar, alternating with the bases of the large processes. All these characters are absent in our fossil, which has, in addition, positive points of distinction not present in the Anthracotherium, such as the transverse crenulated ridges of enamel, &c. These characters combined strongly mark the Anthracotherium and the fossil as distinct genera.

The only genus remaining for comparison is the Hippopotamus. At a casual examination the fossil seems sufficiently distinct. But the essential points of structure in both are so analogous as to require a strict comparison.

The resemblance is this:—

The last teeth of both have a square shaft surmounted by a coronal, divided into four conical hillocks, brought together by pairs, a transverse ridge or crest in front of the anterior pair, and in the last molar an accessory solitary hillock or spur.

The points of difference are these:—

In the Hippopotamus the pairs of conical processes are brought together, and separated by a longitudinal irregular cleft, of which the sides are nearly vertical. The processes are marked on each side by a vertical narrow furrow, so that in detrition the discs are trefoiled when the processes of each

[1] This reservation is made, because, although the four hillocks may well be inferred to be distinct and conical, the detrition of the last tooth leaves the character apparent but in two.

pair are distinct, and of a quadrilobal figure when they have run together. This character is very marked in the large species, and the structure on which it depends is more or less present in all, although in the small species described by Cuvier, it is so marked by the obliquity of the plane of detrition as to be little apparent. In all the species the undivided portion of the shaft is low, and the processes are so much in relief from it, that the vertical height of the latter is several multiples of the height of the shaft. The curvature of the processes is directed inwards, so that the apices of each pair are brought considerably within the margin of the shaft. The spur is a simple hillock; there is but one transverse crest or ridge, the anterior one.

In the fossil the height of the tooth, compared with its other dimensions, is much less than in the Hippopotamus. The shaft is not so low, and the prominence of the processes in relief from it is less than the height of the shaft. Their form is, consequently, shortly conical. The longitudinal cleft is not a vertical fissure: it is an open hollow, and the sides of the hillocks slope outwards at a considerable angle with it. The curvature of the hillocks is but slight, and their points are not brought much inwards, so that they are, as it were, seated marginally. They are not furrowed vertically so as to give anything approaching a trefoil in detrition, and their grinding plane is very oblique, compared with the large species of Hippopotamus, fossil and recent, although not so much in contrast with the smaller. They have a transverse crest in the hollow between the outer hillocks, and another between the outer posterior hillock and the spur, neither of which is present in the Hippopotamus. The spur is strongly bifid, so as to resemble two hillocks in apposition, like that of the large Mastodon, and not simple, as in the Hippopotamus.

These points of distinction are so marked as to establish the generic difference of the fossil from the Hippopotamus.

It appears, therefore, that there existed formerly in the North of India, associated with the Mastodon, the fossil Elephant, the Rhinoceros, and the Hippopotamus, a pachydermatous animal of large size, distinct from all known fossil or recent species, and adding another genus to this numerous fossil family. Our knowledge of its structure is at present confined to the posterior molars, which connect it with the Hippopotamus, the Hog, and the Anthracotherium. But till the entire composition of its dentary system is known we must remain in the dark regarding its strict analogies and position among the Pachydermata. From the active and extensive search, however, which is at present made near the valley of the Murkunda by fossil collectors employed by

several independent inquirers, we may expect that, amidst the immense quantity of bones which are continually met with, the débris of this animal will be found in sufficient abundance to lead to a knowledge of all the main points of its osteology. From the form of the posterior molars we have designated the animal *Tetraconodon*, with the specific name of *magnum*, from its large size,[1] which appears nearly to have approached that of the Hippopotamus and the Indian Rhinoceros, as will be seen by a comparison with the corresponding teeth of these animals.[2]

	Tetraconodon magnum	Existing Hippopotamus	Large Fossil Hippopotamus of Europe	Large Fossil Hippopotamus of the Murkunda. *H. Sivalensis*	*Rhinoceros Sivalensis*
Length of the last molar of upper jaw .	2·05	2·1	2·3	2·25	2·3
Width of ditto .	1·48	2·1	2·3	1·81	2·5

The occurrence of such an animal is, perhaps, not more than might have been looked for. The discovery by Crawfurd and Wallich, on the Irrawaddi, of two new species of Mastodon, peculiar to India, gave reason to expect corresponding new results among other Pachydermata. Our researches in the Murkunda have borne out this idea. The *Tetraconodon magnum* is not the only new animal which we have found in this vast Golgotha; but we have not yet had the opportunity or leisure of examining the bones in detail fit to make the results public. We can only allude to them at present. Among others, we have several portions of the jaws and heads of what we believe to be a new species of Hippopotamus, in which the canines, instead of being furrowed longitudinally by a deep fossa on the inner side, have the sides meeting inwards in a sharp edge.

The fragment of the jaw of the Tetraconodon was got by a native collector employed by Lieuts. Baker and Durand, and it is now in the joint collection of these gentlemen, who have kindly permitted us to make use of it for publication in the journal of the Asiatic Society.

[1] From τέτρα, κῶνος, and ὀδούς. This name must not be confounded with the *Tetracaulodon* of some later American authors, applied to individuals (?) of the large Mastodon, with incisives in the lower as well as the upper jaw.

[2] The measurements, which were omitted in the manuscript, have been made by me in the Museum of the Royal College of Surgeons and in the British Museum, with the assistance of Mr. Flower and Mr. Davis.—[Ed.]

VI. ON THE SPECIES OF FOSSIL RHINOCEROS FOUND IN THE SEWALIK HILLS.

[Three species of fossil Rhinoceros from the Sewalik hills are figured in the Fauna Antiqua Sivalensis (Plates LXXII. to LXXIX.), viz.: *R. Sivalensis*, *R. Palæindicus*, and *R. platyrhinus*, the two former characterized by the curved line of the upper plane of the head, the last by the upper plane of the head being straight and broad. (See Pl. XIV.) No complete description of the species was ever published or written by Dr. Falconer. The following account, which appears to refer mainly to *R. Sivalensis* (although the possibility of there being two species is hinted at), is extracted from a memoir on Sub-Himalayan Fossils, by Messrs. Baker and Durand, published in the Journal of the Asiatic Society for August, 1836, vol. v. p. 490. The annexed illustrations are copied from the Fauna Antiqua Sivalensis, and the reader is referred to the descriptions of the Plates in the Fauna for further particulars. Professor Owen, in his 'Odontography'[1] makes the following statement. 'In one of the extinct species of Rhinoceros from the Himalayan tertiary beds, Dr. Falconer informs me that there are six incisors in both jaws; the typical number was, therefore, retained in this ancient species, as in the contemporary Hippopotamus of the same formations.' The species referred to was evidently *R. Sivalensis*, for Plates LXXII. fig. 4 *b*, LXXIV. fig. 4, and LXXV. fig. 10, F.A.S., of the Fauna Antiqua Sivalensis, show that the remark does not apply to *R. platyrhinus* or *R. Palæindicus*. (See Pl. XIV. fig. 4.) The following note, also, on Colonel Baker's large specimen of the skull of the *Rhinoceros platyrhinus* in the British Museum, was written by Dr. Falconer in his Note-book for 1860: 'The molars are in fine condition, six on either side. The last true molar is only just touched by wear. The last true molar is exactly like *R. hemitœchus*, in having a posterior basal funnel-shaped pit; while the penultimate and antepenultimate true molars, and the penultimate and antepenultimate milk molars, have each three distinct fossettes, as in *Rhinoceros tichorinus*! The vertical ridges of the outer side are very well pronounced in three valleys. The animal had two large incisors above and four below: of the latter, the two outer are big, the two inner small, as in the existing Indian Rhinoceros.' In the 'Fauna Antiqua Sivalensis,' there are likewise illustrations of fossil Rhinoceros from Perim Island (*R. Perimensis*), and from the valley of the Nerbudda.—Ed.]

[1] Vol. i. p. 589.

I.—Description by Messrs. Baker and Durand of the Fossil Rhinoceros of the Sewalik Hills.

(Reprinted from the Journal of the Asiatic Society for August, 1836.[1])

Cranium.—We shall commence with the fossil which, being the most perfect, affords the best means of instituting a comparison with the skulls of described species.

The fossil cranium is imperfect in the following parts. The extremity of the nasal and intermaxillary bones is broken off; the zygomatic arches are both fractured; the left occipital condyle is wanting; the following molars have either dropped out prior to the envelopment of the head by the matrix, or have been broken off subsequently to its fossilization, viz. the fifth of the right, the first and seventh of the left, maxilla. In addition to these losses, the cranium has undergone, when in the stratum, the common fate of Sub-Himalayan relics, and is cracked in several directions; the crush, however, which produced these cracks has not materially altered the form of the head; the chief effect produced has been the forcing the left half of palate at its anterior extremity a little above its proper level; this the longitudinal crack passing through the left orbit enabled it to accomplish; the displacement resulting may be best observed in the profile view of the skull, fig. 3. The transverse cracks are accompanied by a small hollow and a consequent neighbouring bulge, both so partial and of such small relief, that in the profile their places can only be observed by paying attention to the jagged outline at the depression of the frontals. With the above exceptions the specimen is perfect.

A glance at Pl. XV. will be sufficient at once to determine the species with which this fossil rhinoceros must be compared. The depression of the frontals causing the deeply curved outline of the upper planes of the head, the slope of the occiput, the septum, and the nasal arch all separate this cranium from the existing and fossil bicorn species. The existing unicorn species is that, therefore, to which recourse must be had in order to establish a comparison.

In the unicorn rhinoceros of Java the height to which the crest of the occiput rises above the palatal plane, and also the thickness and prominence of the nasal arch supporting the horn, are less than in the Indian rhinoceros. A line drawn at a tangent to the crest of the occiput and the highest point of the nasal bones will, in the unicorn species of India, be more raised above the plane of the frontals than is the case in the Javanese rhinoceros. In the foregoing respects the fossil associates itself with the Indian, and differs from the Java, species. The comparison may, therefore, in general be confined to the former.

With the view of bringing at once under the eye, the discordance which occurs between the relative values of analogous dimensions, the subjoined table is here inserted. The modulus chosen is the space occupied by the seven molars, because on this measurement the development of the bones of the head must, to a certain extent, be dependent. The measurements given in Cuvier's 'Oss. Foss.' have afforded the proportions of the existing species; and the table of dimensions which closes this paper has given the proportions of the fossil.

[1] The illustrations referred to are those in the 'Journ. Asiatic Society.'—[Ed.]

DESCRIPTION OF PLATE XIV.

RHINOCEROS SIVALENSIS AND RHINOCEROS PLATYRHINUS.

Fig. 1. Profile view of skull of *Rhinoceros Sivalensis*, with three true molars and three posterior premolars, one-eighth of the natural size. Copied from a drawing by Mr. Dinkel, in the Fauna Antiqua Sivalensis, Plate LXXIII., fig. 2 *a*. The specimen is in the British Museum. (See pages 157 & 514.)

Fig. 2. Fragment of upper jaw, right side, of *Rhinoceros Sivalensis*, with three true molars and two last premolars, one-fourth of the natural size. Copied from a drawing by Mr. Ford in the F. A. S., Plate LXXV., fig. 5. The specimen is in the British Museum. (See pages 157 & 516.)

Fig. 3. Profile view of cranium of *Rhinoceros platyrhinus*, one-eighth of the natural size. Copied from a drawing by Mr. Dinkel, in the F. A. S. Plate LXXII., fig. 1. The specimen is in the British Museum. (See pages 157 & 513.)

Fig. 4. Lower jaw, with incisive border of *Rhinoceros platyrhinus*, showing two outer large and two central small incisors, one-fourth of the natural size. Copied from a drawing by Mr. Ford, in the F. A. S. Plate LXXV., fig. 10. The specimen is in the British Museum. (See pages 157 & 517.)

Fig. 2.

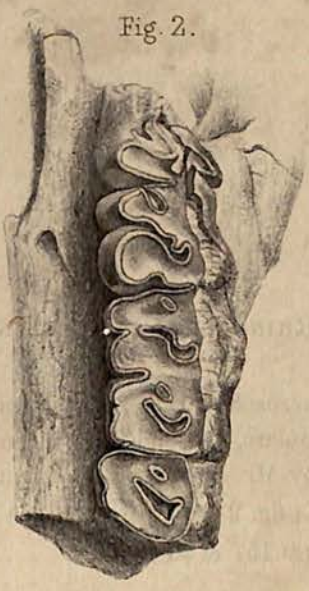


Fig. 4.

Fig. 1.

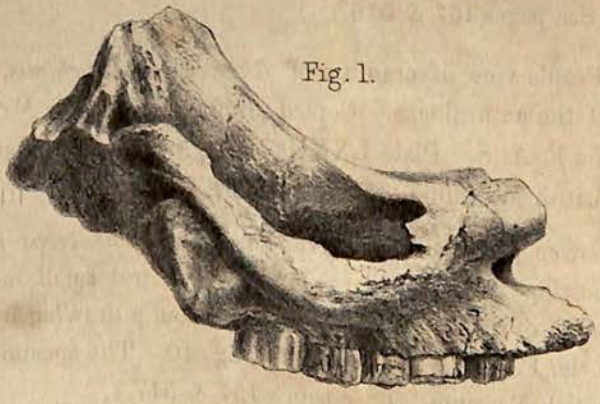
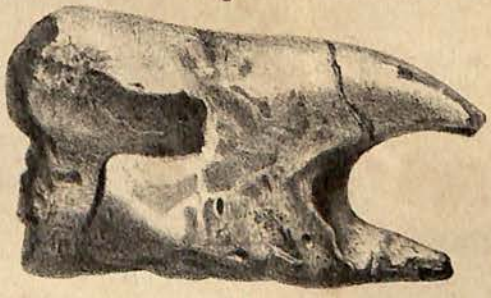


Fig. 3.



G.H.Ford del. J.Dinkel lith. W.West imp.

1, 2. Rhinoceros Sivalensis. 3, 4. R. platyrhinus.

Measurement	Cuvier's Ind. Rhin.	Fossil Ind. Rhin.
Space occupied by the seven molars assumed equal to.	1·00	1·00
Height of occiput from lowest edge of occipital foramen to summit of crest of occiput	1·02	0·80
Greatest breadth of occiput	1·11	1·05
Least thickness of cranium across temporals	0·45	0·38
Breadth across at post-orbital apophysis of frontals	0·83	0·78
Distance from anterior of orbit to auditory foramen	1·02	1·00
Breadth across the occipital condyles.	0·47	0·60

Referring to the table of dimensions it will be observed, that the height of the occiput is in the fossil less by mèt. 0·021 than the corresponding measure of Cuvier's Indian rhinoceros; but the greatest breadth of the occiput is mèt. 0·036 in favour of the fossil; relatively to the space occupied by the seven molars, these two measurements attain a less development in the fossil than in the existing animal. The difference in the occipital condyles amounting to mèt. 0·065 in excess of the Indian rhinoceros causes a marked discordance in the ratios of these dimensions; but, as the left condyle and the adjacent parts are wanting in the fossil, the measure was obtained by doubling what appeared to be the exact half dimension; this of course is not so satisfactory as if the condyles had been perfect; any inaccuracy consequent on this circumstance could not, however, amount to a quantity which would materially alter the deduced proportion. The occiput, figs. 8, 9, Pl. XVII., is fortunately very perfect; from its dimensions, which prove it to have belonged to a smaller animal than the cranium of Pl. XV., it may also be concluded, that though inferior in size to Cuvier's specimen of the Indian rhinoceros, which in greatest breadth of occiput exceeds it by mèt. 0·039, yet the space occupied by the condyles is 0·010 in favour of the small fossil occiput. In both of the fossils the depressions near the summits of the occiputs on each side of the mesial projections are deeper than those of the existing species.

The zygomatic arches not being entire, and the matrix being uncleared from the portions which remain, no particular remarks can be passed on them.

The sutures cannot anywhere be traced; a circumstance which precludes the notice of particulars frequently of importance in the comparison of species.

The least thickness of the cranium is but mèt. 0·001 greater than that of the Indian rhinoceros; and therefore in proportion to the modulus, yields a less ratio than that species.

The breadth at the orbits is mèt. 0·024 greater than in the existing species; consequently the skull does not in this part present any material discordance of proportion.

The length between the auditory foramen and the anterior of the orbit is 0·043 mèt. greater in the fossil; this measurement affords a proportion only differing mèt. 0·002 from that obtained from the existing species.

The infra-orbital foramen is situated similarly to that of the Indian rhinoceros.

The nasal arch is massive and much developed; the spring of this arch is perpendicularly over the anterior of the second molar; that is a little more retired than in the Java or Indian rhinoceros skulls, given in Cuvier's Pl. IV.

The breadth of the palate has not been given in the table of dimensions, because the first and seventh molars not being perfect on both sides, measurements corresponding to those of Cuvier's could not be obtained. It is comparatively less than in the existing species, but the great breadth of the teeth compensates for this difference.

Having detailed the essential differences and the points of resemblance observable in the fossil Indian rhinoceros when compared with Cuvier's dimensions of the existing Indian rhinoceros, we must be permitted to add, that additional measurements from skulls of the latter species are requisite before anything certain can be pronounced as to the amount of difference or correspondence between the two species. We are indueed to make this remark in consequence of having been favoured with the examination of two craniums which presented considerable variation of proportions when compared with Cuvier's and with each other.

It appears to us desirable, therefore, to ascertain the limits within which individual variations range before anything positive can be asserted. The foregoing remarks will have shown a great general resemblance, accompanied by a departure of proportions in some corresponding parts; the latter may be sufficient for the establishment of a new species—at least for the present, until more data are obtainable whence to determine the bounds by which the individuals of one species are limited in their variations. For the sake of distinction, therefore, and present convenience, at the same time keeping in view the type to which it is a near approach, we have termed the species under consideration the *R. Indicus fossilis.*

Teeth.—The remark has been already passed, that the greater number of fossils obtained from the Moginund deposit are the remains of young animals; with the rhinoceros this has been particularly the case. We accordingly find ourselves better able to illustrate the early stage of dentition than that more advanced.

Fig. 1 contains the four milk molars of the left maxilla; the fourth being but just cut is unworn; but the palate being broken away from the base of the tooth, more of it is seen than would otherwise be the case; in the right half of the specimen, where the palate is whole, the fourth molar is more concealed. The first molar is also unworn, but the second and third have suffered detrition. The two rows of teeth have their internal base lines parallel to each other, and the lines which would circumscribe their exterior much curved, in consequence of the difference of breadth which exists amongst the teeth. The upper part of an unworn tooth, measured exteriorly, is much longer than the lower; for the anterior of each molar projects beyond the posterior extremity of the one immediately in its front by the gradual enlargement of the external line of enamel from the base to the summit. As the molars wear down, this outer development is reduced, the internal sides of the teeth come more into use, and breadth is gained in compensation for the diminished length of surface in wear.

Fig. 5, Pl. XIX. The sixth molar from a left maxilla. The spur, which occupies no inconsiderable part of the hollow between the

anterior and posterior transverse hillocks, is here less curved than that of the Indian rhinoceros; and there is wanting altogether the small salient of enamel, which in the Indian rhinoceros occurs between the starting point of the above-mentioned spur and the point of junction of the exterior and anterior main lines of enamel. It may also be mentioned, that the exterior and posterior lines of enamel being less thick than the corresponding parts of the sixth molar of the Indian rhinoceros, there is a greater space between the two. Such modifications of form are however fortuitous, differences of equal amount being observable in the teeth of animals of the same existing species.

This fossil measures in length . .	in. 2·50	mèt. 0·0645
„ in breadth . .	„ 2·62	„ 0·0675

Fig. 6. The 5th molar, derived from a left maxilla. The outline of its enamel accords with that of the similar tooth of the Indian rhinoceros, the only difference being in the dimensions and in the emamellated edge of the short beading at the anterior side of the tooth.

It measures in length	in. 2·08	mèt. 0·053
„ in breadth	„ 3·27	„ 0·0835

Fig. 7 is the 7th molar, and from a right maxilla; the point of the small spur is broken, as also the anterior extremity of the external line of enamel; but the tooth is sufficiently perfect to show a close resemblance to the analogous molar of the Indian rhinoceros.

It measures in length	in. 2·88	mèt. 0·0735
„ in breadth	„ 2·53	„ 0·065

Fig. 8 is the 7th molar, of a left maxilla. The difference observable between this and the foregoing specimen consists in the great development which the small anterior spur here attains. In the former, it is scarcely observable; in fig. 8 it is very prominent. Variations to an equal amount may, however, be observed in the minor salients, &c., of enamel in teeth appertaining to skulls of the same existing species. No weight can therefore be attached to such unimportant modifications.

This fossil measures in length . .	in. 2·95	mèt. 0·075
„ in breadth . .	„ 2·55	„ 0·065

The cranium Pl. XV. has its molar teeth so much worn down that the configurations of the enamel cannot be traced. The table of dimensions gives the length and breadth of each tooth, and shows that although the lengths do not materially differ from those of the corresponding teeth of the existing species, the breadths exceed those of any hitherto described.

Without complete illustrations of the milk-teeth of existing species, it would be dangerous to attempt a comparison between them and the fossil Indian rhinoceros. We have therefore avoided the endeavour; but we must be allowed to notice the upper jaw fig. 4, Pl. XIX., which offers peculiarities when compared with figs. 1, 2, and 3 (of the same plate), deserving of remark.

The right half of the specimen is figured in the plate, the left half having lost the first tooth. With respect to age, this jaw nearly corresponds with fig. 3, the fifth molar being in both on the point of appearance. The following departures from the tracing of enamel in figs. 1, 2, and 3, may, however, be observed. The second molar of

fig. 4 has this peculiarity, that instead of the anterior portion of the tooth being one continuous offset from the exterior line of enamel, it only assumes that appearance after considerable detrition, consisting at first of a short offset and an isolated pillar, as shown in the drawing. The two sides of the jaw have been very unequally worn, in consequence of which the opposite side to that delineated has the pillar and offset conjoined. The third molar also presents a marked difference when placed in juxtaposition with the corresponding teeth of the other three jaws: the two spurs which occupy the central hollow of the tooth are of a different shape from that which occurs in the other specimens. In other respects, fig. 4 corresponds with them: its rows of molars are parallel to each other, and the dimensions offer but trifling variations. The modifications of form above alluded to, unless fortuitous, which is perhaps improbable, denote the existence of another species—a fact corroborated by the examination of the milk molars of the lower jaws in our possession. Upon the consideration of these we now enter, but are able to offer but few and unsatisfactory remarks.

Lower Jaws.—With the exception of the fine fragment, fig. 6, Pl. XVI., submitted to our inspection by Conductor Dawe, and the fragment, fig. 9, the specimens of lower jaws are all from the Maginnud deposit, and all the remains of young animals.

Fig. 1, Pl. XVI., represents a fossil which has lost the interior of its symphysis, the second molar on the right, and the first molar on the left side of the jaw, as also both the rami, which are broken off. Four molars have appeared, the second and third of which are worn; but the first and fourth have their enamel intact. The sections of fracture expose germ teeth. The two lines of molars have a gentle convergence, which is effected, not by a curve in the rows of teeth, for these are set in a perfectly straight line, but by the gradual approach of the two rows, which make a small angle with the median line of the jaw. The section shown by the break of the symphysis and the interval between the front molars argues the existence of a prolonged symphysis. The fourth molar is characteristic, having an isolated point or low pillar in the centre of the chord of its posterior crescent.

Fig. 4 is the right half of the lower jaw of a young rhinoceros, but of one somewhat older than the animal to which fig. 1 belonged, for the fourth molar has in fig. 4 suffered detrition. Notwithstanding the difference of age being in the favour of this specimen, the space occupied by the four molars is less than that of the four in fig. 1. The fourth molar is here devoid of the low isolated pillar in the posterior crescent, and has the central enamel, or junction of the two crescents, larger than in fig. 1. There are no means of ascertaining whether or not the opposite rows of molars were parallel, but in the position of symphysis and set of the teeth in a perfectly straight line, this specimen corresponds with the foregoing.

Fig. 2 has its fourth molar just disclosed, and rising into the line of molars. It is devoid of the isolated pillar; but in size corresponds with fig. 1, instead of fig. 3, to which latter it assimilates itself by the fourth and second molars.

It is difficult to ascertain the degree of importance to be attached to such points of difference. In no specimen from the jaw of an adult

animal has any trace of the isolated pillar been hitherto found. Occurring as this peculiarity does in a deciduous tooth, should nothing similar take place in the permanent tooth which replaces it, the only chance of determining the question will be the discovery of an entire head. We have noticed an upper jaw, fig. 4, Pl. XIX., which indicates the probability of the existence of two species. The examination of the above lower jaws rather confirms this supposition; but in the event of such slight modifications denoting specific distinctions, we are unable, in consequence of the paucity and incompleteness of specimens, to decide which are the milk-teeth of the fossil Indian rhinoceros. Nor are we fortunate with respect to the lower maxilla of the adult animal; figs. 6, 7, and figs. 8, 9, being all that we can bring forward. The sections of these two fragments differ, in consequence of their being derived, one from the posterior, the other from the anterior part of the jaw, which thickens as it approaches to the symphysis. These two specimens resemble the corresponding portions of the lower jaw of the Indian rhinoceros, but are too imperfect to afford any satisfactory measurements for grounds of comparison.

Anterior Extremity.

A scapula in our possession is not sufficiently perfect to give accurate measurements, but it bears as great a general resemblance to that of the Indian rhinoceros as do the other parts of the skeleton.

The humerus, figs. 1, 2, Pl. XVII., having its radius and ulna attached, was discovered by ourselves very close to the place whence we excavated the femur and tibia forming the subject of Pl. XVIII. With the exception of the deltoid crest, this humerus is perfect, and has afforded the dimensions which enter into the first column of the table. For the purpose of comparison, the five following columns are added. The proportions of the Indian and Sumatra small species of rhinoceros are deduced from Cuvier's table; those of the fossil specimens are of course from the Table of Dimensions. The length of the bone is assumed as the unit, and the measures of other parts referred to it, in order to obtain their comparative values.

Measurements	Cuvier's Ind. Rhin.	Cuvier's Sumatra Small Sp. Rhin.	Fig. 1, Pl. 17, fossil Ind. Rhin.	Fig. 5, Pl. 17, fossil Ind. Rhin.	Fig. 6, Pl. 17, fossil Ind. Rhin.
Length of humerus from tuberosity to external condyle	1·00	1·00	1·00	1·00	1·00
Ditto ditto ditto internal ditto	1·03	0·95	0·91	0·94	...
Greatest anter. post. diameter at top	0·44	0·30	...	0·44	0·43
Breadth across condyles	0·36	0·31	0·35	0·37	...
Ditto of articulating pulley	0·25	0·19	0·22	0·22	0·25
Least diam. of the body of the humerus	0·15	0·13	0·14	...	0·15
Length of radius	0·79	0·75	0·76	...	...
Breadth at top	0·26	0·20	0·23	...	...
Ditto at bottom	0·25	0·18	0·23	...	...
Length from articulating head to bottom of internal condyle	...	...	0·82	0·81	0·87

The Sumatra rhinoceros (small species) concurs with the fossil Indian rhinoceros in having the length taken to the external condyle longer than that taken to the internal. The Javanese and the larger Sumatra species also accord with the fossil in this respect, but not so nearly as the small Sumatra species, which has consequently been introduced into the above table.

The length of the fossil humerus, figs. 1, 2, Pl. XVII., exceeds that of any of the existing species: its thickness is, in proportion to the length of the bone, intermediate between the Sumatra and Indian species. The articulating pulley also possesses a development intermediate in value to those of the two existing species. The breadth at the condyles is in the same proportion, or nearly so, as that of the Indian rhinoceros. The radius is in length, considered with reference to length of femur, a little less than in the Indian, and somewhat in excess of the small Sumatra species. The remaining two dimensions of this bone yield values intermediate to those of the two existing rhinoceroses. These remarks apply to the deductions for fig. 1; nor would it be necessary much to alter them in speaking of fig. 5; but fig. 6 presents such a close approximation to the Indian rhinoceros, that it is much to be wished that the specimen had not been so broken as to prevent additional measurements being derived from it. Excepting in the length from the articulating head to the bottom of the internal condyle, it does not much differ from fig. 5. The bone, however, being imperfect, must be omitted in drawing a comparison between the fossil and existing species.

Fig. 1 varies most from the Indian rhinoceros in the proportion of the length taken to the internal condyle—an anomaly difficult of explanation. We must here repeat, that there exists a necessity for a greater number of tables of dimensions taken from the skeletons of the Indian rhinoceros. The anterior extremity of a rhinoceros, with the examination of which we have been favoured, yielded proportions so nearly corresponding with those deduced from the fossil humerus, figs. 1, 2, as to prevent our drawing more positive conclusions than those expressed at the close of the remarks on the cranium, Pl. XV.

Posterior Extremity.

The femur and tibia, Pl. XVIII., were dug up in such close proximity to the humerus and radius, fig. 1, Pl. XVII., that little doubt could be entertained of their having belonged to the same animal. Being perfect, except at the lower part of the great trochanter, the specimen affords ample means of comparison with the femur of the existing species.

On reverting to the Table of Dimensions, it will be observed that this fossil exceeds, as did also the humerus, any of those in Cuvier's table of existing species. The following columns show in what respects the proportions of the bone vary from those deduced from Cuvier's Indian rhinoceros. The length of the femur is here the modulus.

From a comparison of the two first columns in the annexed table there results that the fossil has a greater development at its upper, and a somewhat less development at its lower extremity, than is the case in the Indian rhinoceros. The third trochanter is set lower down, and the inferior extremity of the small trochanter higher up than in the existing

species; the articulating head is larger in proportion in the fossil than in the Indian rhinoceros. None of these modifications, however, are excessive; on the contrary, they are less than those which exist amongst the fossils themselves, which are all three undoubtedly of the same species.

Measurements	Cuvier's Ind. Rhin.	Fossil Pl. 18	Fossil 3rd in table of dimensions	Fossil 5th in table of dimensions
Length of femur from articulating head to bottom of internal condyle .	1·00	1·00	1·00	1·00
Breadth from head to most salient part of great trochanter	0·38	0·43	...	...
Breadth across condyles . . .	0·29	0·28	0·26	...
Antero-post. diam. of internal condyle .	0·34	0·34	...	...
Ditto ditto of external ditto. . .	0·27	0·26	...	...
Distance between bottom of 3rd trochanter and top of 1st . . .	0·59	0·61	...	...
Ditto ditto ditto small trochanter and top of head of femur. . . .	0·46	0·41	0·46	0·42
Diam. of articulating head of femur .	0·18	0·19	0·16	0·17
From lower side 3rd trochanter to bottom of external condyle . . .	...	0·38	0·38	...
Length of femur from articulating head to bottom of 3rd trochanter . .	...	0·72	0·71	0·64
Length of tibia from anter. tubero. to anter. edge of inferior articulating surface	0·67	0·70	...	...
Greatest transverse diam. at top . .	0·25	0·25	...	...
Antero-post. diam. from antero-post. tubero. to post. ext. of internal condyle.	0·29	0·31	...	...
Transverse diam. at bottom. . .	0·21	0·20	...	...
Diam. antero-post. of internal side .	0·14	0·13	...	...
Length of fibula	0·62	0·65	...	...
Breadth at bottom	0·10	0·10	...	...

From the manner in which the lower and exterior part of the great trochanter is broken there is every probability that a descending point protruded from the fractured surface towards the third trochanter, the ascending point of which is very perfect.

The third trochanter, however, differs from that of the existing species as figured in Cuvier's 'Oss. Foss.,' in not possessing the double point; for it has a single well-defined ascending process, without any sign of the bicuspid termination. The lower edge of this trochanter, instead of ascending with a gradual swell towards the point, as in the existing species, has a counter curvature to that of the upper edge. The chief dissimilarity between Cuvier's plate and the fossil occurs in this part of the bone, the third trochanter assuming a different shape, and offering a variation more distinctive than any other presented in either extremity. This circumstance, together with some of the proportions of the cranium, has led us for the present to distinguish these remains by appending the word fossil to the name of that species of which they are the prototype. But we dwell on the necessity of more

extended research, and the collection of a greater series of tables of dimensions of the Indian rhinoceros, before anything absolutely conclusive can be pronounced with regard to the fossil and existing species.

We have had no hesitation in ascribing the two limbs dug up in such close neighbourhood to the same animal. An additional confirmation of the correctness of the assumption may be derived from the proportion which exists between these two extremities, when compared with that which occurs in the Indian rhinoceros.

Ind. Rhin. femur and tibia	mèt. 0·960	humerus and radius	mèt. 0·868
Fossil Ind. Rhin. do. do.	„ 1·056	ditto ditto	„ 0·947

In the first, the humerus and radius are to the femur and tibia in the ratio of 1 : 1·10; in the fossil, the ratio is 1 : 1·11.

The analogy which exists between these fossil extremities and those of the Indian rhinoceros being no less striking than that which was observed between the cranium, Pl. XV., and the skull of the existing species, we have considered such correspondence sufficient to prove that the fossil anterior and posterior limbs appertained to an animal of the same species, and of about similar size to the one of which the cranium in question is a relic.

Even in the event of a much closer approximation of symmetrical proportions than that given in this paper being obtained, we are aware that identity of species could not be presumed. It could not be assumed that the skin and the external appearance of the animal were precisely similar to those of the existing species. The fossil Indian rhinoceros must, however, have presented a figure bearing a strong general resemblance to the uncouth symmetry of its present representative.

Measurements of Anterior Extremity.	Sp. 1		Sp. 2		Sp. 3		Sp. 4		Sp. 5	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Length of humerus from tub. to external condyle	·538	21·20	·488	19·22	·482	19·0	...	...	...	...
Do. do. do. internal do	·492	19·38	·461	18·15	...	...	...	...	...	...
Greatest anter. post. diam. at top	...	...	·218	8·60	·208	8·20	·200	7·90	...	...
Breadth across condyles	·193	7·60	·183	7·22	...	...	...	...	·176	6·94
Breadth of the articulating pulley	·119	4·70	·111	4·40	·121	4·80	·104	4·10	·109	4·30
Least diam. of the body of the humerus	·078	3·07	...	...	·073	2·90	·071	2·82	·069	2·75
Length of the radius	·409	16·10	...	...	..	...	...	...	...	...
Breadth at top	·124	4·90	...	...	...	...	...	...	...	...
Ditto at bottom	·124	4·90	...	...	...	...	...	...	...	...
Length of humerus from art. head to internal condyle	·441	17·40	·393	15·51	·420	16·55	·389	15·35	·398	15·70

Measurements of Posterior Extremity	Sp. 1		Sp. 2		Sp. 3		Sp. 4		Sp. 5		Sp. 6	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Length of femur from ant. head to bottom of 3rd trochanter	·449	17·70	...	...	·383	15·10	...	...	·328	12·94	·369	14·56
Length of femur from ant. head to bottom of internal condyle	·621	24·45	...	...	·539	21·25	...	...	·510	20·10	...	...
Breadth from head to most salient part of great trochanter	·269	10·60	...	...	...	...	...	...	...	...	...	...
Breadth across condyles	·173	6·82	...	...	·143	5·63	·146	5·75	...	...	...	...
Antero-post. diam. of internal condyle	·214	8·45	·221	8·70	...	...	·166	6·55	...	...	...	...
Ditto do. do. external condyle	·161	6·35	·162	6·40	...	...	·139	5·48	...	...	...	...
Distance between bottom of 3rd trochanter and top of 1st	·383	15·10	...	...	...	...	...	...	...	...	...	...
Distance between bottom of small trochanter and top of head of femur	·259	10·20	...	...	·249	9·80	...	...	·215	8·50	·231	9·10
Diam. of articular head of femur	·118	4·65	...	...	·086	3·40	...	...	·089	3·50	·083	3·30
From lower side 3rd trochanter to bottom of external condyle	·242	9·53	·177	7·00	·208	8·20	·266	10·50	...	...	...	...
Length of tibia from anter. tubero. to anter. edge of infer. artic. surface	·435	17·15	...	...	...	...	...	...	...	...	...	...
Greatest transverse diam. at top	·156	6·15	...	...	...	...	...	...	...	...	...	...
Antero-post. diam. from anter. tub. to post. ext. of internal condyle	·195	7·70	...	...	...	...	...	...	...	...	...	...
Transverse diam. at bottom	·128	5·05	...	...	...	...	...	...	...	...	...	...
Diam. of antero-post. internal side	·086	3·40	...	...	...	...	...	...	...	...	...	...
Length of fibula	·405	15·95	...	...	...	...	...	...	...	...	...	...
Breadth at bottom	·064	2·54	...	...	...	...	...	...	...	...	...	...

Measurements of the Head	Cranium		Occiput	
	Mèt.	In.	Mèt.	In.
Height of occiput from lowest edge of occipital foramen to top of crest	0·259	10·20	0·223	8·78
Greatest breadth of occiput, behind auditory foramen	0·341	13·44	0·266	10·50
Least thickness of cranium at temporal bones	0·126	4·95	...	...
Breadth between post. orbital apophysis of frontals	0·254	10·00	...	...
Distance from anterior of orbit to auditory foramen	0·325	12·80	...	...
Space occupied by the seven molars	0·324	12·75	...	...
Breadth across occipital condyles	0·195	7·70	0·140	5·51
Ditto of occipital foramen	...	...	0·0575	2·25
Height of ditto ditto	...	...	0·049	1·90
Distance between internal extremities of glenoid facets of temporal	...	...	0·0735	2·88
Ditto from lower edge of occipital foramen to median post. extremity of palate	0·368	14·50	...	...
Ditto from post. of right occipital condyle to spring of nasal arch	0·539	21·22	...	...
Ditto ditto ditto to anterior of orbit	0·449	17·71	...	...
Depth from edge of maxilla at 5th molar to upper surface of frontals	0·239	9·42	...	...
Greatest transverse width of nasals at horn site	0·174	6·86	...	...
Ditto external breadth at 6th molar	0·246	9·72	...	...
Thickness of cranium over the median post. extremity of palate	0·204	8·06	...	...
Height of highest point of nasal arch above anterior of palate	0·238	9·38	...	...
Perpendicular from a line tangential to the summit of crest and vertex of nasal arch to the depression of frontals	0·099	3·91	...	...

Measurements of Upper Molars	1st Sp.		2nd Sp.		3rd Sp.		4th Sp.		5th Sp.	
	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.
Greatest length										
Molar 1	...	...	·030	1·19	·0295	1·14	·030	1·20	...	...
2	·035	1·36	·034	1·335	·038	1·49	·0395	1·53	·039	1·49
3	·045	1·75	·0475	1·85	·053	2·07	·056	2·17	·045	1·74
4	·049	1·92	·058	2·26	·061	2·39	...	...	·056	2·20
5	·044	1·69	·061	2·37	...	...	...	...	...	...
6	·0495	1·95	...	...	...	...	...	...	...	...
7	·0755	2·96	...	...	...	...	...	...	...	...
Greatest breadth										
Molar 1	...	...	·024	0·95	·024	0·95	·0285	1·09	...	...
2	·059	2·31	·0385	1·5	·036	1·40	·041	1·58	·037	1·45
3	·080	3·15	·049	1·9	·045	1·88	·053	2·05	·051	2·007
4	·083	3·36	·0575	2·25	...	...	...	...	·059	2·30
5	·081	3·19	...	...	...	...	...	...	...	...
6	·089	3·48	...	...	...	...	...	...	...	...
7	·083	3·25	...	...	...	...	...	...	...	...

Measurements of Lower Molars		Sp. 1		Sp. 2		Sp. 3	
		Mèt.	In.	Mèt.	In.	Mèt.	In.
Greatest length of Molar . .	1	·016	0·61	...	...	·017	0·67
"	2	·037	1·44	·0335	1·30	·033	1·29
	3	·053	2·09	·050	1·98	·0425	1·67
	4	·047	1·82	·056	2·18	·046	1·79
	5	...	...	...	...	...	...
	6	...	...	...	...	...	...
	7	...	...	...	...	...	...
Greatest breadth of Molar . .	1	...	...	...	...	·0115	0·46
	2	·020	0·77	·021	0·81	·018	0·70
	3	·026	1·01	·027	1·05	·025	0·98
	4	·029	1·12	·029	1·10	·030	1·19
	5	...	...	...	...	...	...
	6	...	...	...	...	...	...
	7	...	...	...	...	...	...

II.—Description by Dr. Falconer of Fossil Remains of Rhinoceros in Museum of Asiatic Society of Bengal. Reprinted from Catalogue of Museum.

A. From the Sewalik Hills.

No. 269. *Rhinoceros Sivalensis*?—Fragments comprising the greater part of the cranium broken off behind about the posterior parts of the zygomatic arch, the fracture having removed the whole of the occiput and the left zygomatic arch. The specimen had also suffered from a crush acting from above downwards from right to left; the greater part of the parietal and the whole of the frontal, and also the united nasals are present; the right orbit broken off; the left nearly entire. The right maxillary shows the remains more or less of seven molars, the last broken off, the penultimate well worn; the anterior teeth have all their crowns broken off nearly on a level with the alveoli; on the left side, the crowns are all broken off; the palate seems narrow, but this may be probably owing to the crush; the tip of the nasal shows the rugous gibbosity of the base of a *very large* horn. The species was evidently unicorned. From the Sewalik hills near Nahun.

No. 270. *Rhinoceros* —— ?—Lower jaw, left side showing greater part of horizontal ramus, but broken off in front and behind, with the remains of four molars, the crowns all broken off.

No. 271. *Rhinoceros* —— ?—Lower jaw, right side, broken off in front at commencement of symphysis and behind at the coronoid, with remains of five molars, much mutilated. In condition like No. 270.

No. 272. *Rhinoceros* —— ?—Fine fragment comprising the lower end of tibia and fibula, right side, attached to each other and to the bones of the tarsus in their natural position, together with the greater part of the length of three metatarsals also united, and attached to the carpus: the inferior apophysis of the calcaneum is broken off, the tibia bent nearly at right angles with tarsus and metatarsus. All the bones are held together by argillaceous matrix in their natural relative position

in a manner which is remarkable for the fossil state among Sewalik remains. From the clay-marl of Maginnud. Figured by Messrs. Baker and Durand in Journ. As. Soc., vol. v. Pl. XVII. fig. 19.

No. 273. *Rhinoceros* —— ?—Upper extremity of humerus showing the head and upper trochanters; the descending spine of the large tuberosity broken off: of large size.

No. 274. *Rhinoceros* —— ?—Upper extremity of humerus, right side, showing the head and both tuberosities, as also the middle apophysis of the upper end.

No. 277. *Rhinoceros* —— ?—Right femur, articulating head with part of shaft attached; leafy expansion of third trochanter broken off.

No. 278. *Rhinoceros* —— ?—Shaft of femur, left side, articular epiphysis and trochanters broken off, base of leafy expansion remaining.

No. 280. *Rhinoceros* —— ?—Lower end of femur, left side, showing the condyles and trochlear pulley with a short portion of the shaft attached.

No. 283. *Rhinoceros* —— ?—Top of ulna, left side, showing articular pulley and part of olecranon.

No. 285. *Rhinoceros* —— ?—Upper half of right tibia with articular surface nearly entire.

No. 287. *Rhinoceros* —— ?—Astragalus, very perfect, of right side.

No. 288. *Rhinoceros* —— ?—Calcaneum, left side, nearly entire.

No. 289. *Rhinoceros* —— ?—Middle metacarpal of right fore leg entire.

No. 302. *Rhinoceros* —— ?—Entire humerus, left side found embedded in argillaceous matrix, which has been partly removed, laying bare the articular surfaces of both extremities together with the tuberosities, and a great part of the shaft on one side; the lower jaw of a horse, both rami, together with the lower end of the left femur of the same animal united to it on the other side by matrix. The humerus is of large size, and equal to Nos. 273, 274.

Dimensions.

	Inches
Length from tuberosity to external condyle	19·4
To internal ditto	18·8
Width of condyles	4·4

There is great obliquity in the plane of the distal end of the lower articulation, the outer condyle projecting very much beyond the inner, as in Baker and Durand's figure, Journ. As. Soc. vol. v. Pl. XVII. figs. 6 and 7.

A notable specimen as indicative of the manner in which the bones of different animals were washed together into the mud-beds of the Sewalik strata: the Maginnud bone-bed being a stratum of argillaceous earth: the bones soft and white and adhering to the tongue. The mud matrix penetrates into the cores of the hollow bones.

No. 324. *Rhinoceros* —— ?—Molar of upper jaw, nearly entire, with part of palate attached.

No. 326. *Rhinoceros* —— ?—Entire outer incisor, lower jaw right side.

No. 764. *Rhinoceros* —— ?—Lower end, right tibia, of large size.

No. 771. *Rhinoceros* —— ?—Top of right radius with articular surface.

No. 773. *Rhinoceros* —— ?—Astragalus (left) of a small-sized species nearly entire (*vide* No. 287).

No. 782. *Rhinoceros* —— ?—Scaphoid and Semi-lunar of the left carpus of the same individual fitting together and connected by matrix, both of large size.

No. 786. *Rhinoceros* —— ?—Cuneiform bone of left carpus.

No. 787. *Rhinoceros* —— ?—Cuboid of left tarsus agreeing in size nearly with *Rh. unicornis*, but differing in form.

No. 788. *Rhinoceros* —— ?—Fragment of left scapula, comprising glenoid cavity; tuberosity, and neck spine and lamina broken off; of the size of the Indian unicorned Rhinoceros.

B. From Perim Island.[1]

No. 29. *Rhinoceros Perimensis.*—Lower jaw, left side, including part of horizontal ramus, posterior angle and ascending ramus, and portion of the last molar: coronoid and condyle broken off: of very large size. Presented by Lieut. Fulljames.—See Journ. As. Soc., vi. 79.

No. 30. *Rhinoceros Perimensis.*—Fragment consisting of the superior maxilla left side, containing two molars, well worn.

No. 31. *Rhinoceros Perimensis.*—Lower jaw, right side, consisting of posterior angle with one unworn molar, and portion of ascending ramus, in three pieces: of much smaller size than No. 29, and probably of a young animal.

No. 33. *Rhinoceros Perimensis.*—Humerus, inferior end, right side, with articular surface.

No. 109. *Rhinoceros Perimensis?*—Fragment of left scapula comprising the glenoid cavity, neck and tuberosity together with the low commencement of the spine of very large size: the whole of the laminæ broken off. The curve of the glenoid cavity on the antero-posterior direction is very great: and the cup is much less circular than in the most of the known forms of rhinoceros. Doubtful if from Perim island: the matrix resembles that of specimens from Ava.

No. 110. *Rhinoceros Perimensis.*—Part of an upper molar vertically broken through transversely about the middle, agreeing in size with No. 30.

No. 111. *Rhinoceros Perimensis.*—Metacarpal, outer toe, left fore leg with both articular surfaces. The bone is short and the inferior articular surface very thick and oblique.

[1] See also Fauna Antiqua Sivalensis, Pl. lxxvi.

C. From Scinde.

No. 5. *Rhinoceros* —— ?—Inner metacarpal of left fore leg, a little mutilated at the upper articulation. It is proportionally very short and the upper articulation deep as compared with the Indian unicorned rhinoceros.

No. 6. *Rhinoceros* —— ?—Fragment of the left scapula of a very large species, showing the greater portion of the glenoid cavity, neck and a part of the spine: the greater part of the blade broken off. The lower margin of the glenoid cavity partly broken off. Tuberosity of very large size.

No. 8. *Rhinoceros* —— ?—Distal extremity of middle metatarsal, of large size, shaft broken off.

No. 10. *Rhinoceros* —— ?—Fragment of left scapula of a small-sized rhinoceros, showing glenoid cavity, neck and trochanter: blade broken off. Of a much smaller size than No. 6.

D. From Ava.

No. 23. *Rhinoceros* —— ?—Fine fragment comprising the lower half of the right humerus with the articular surface very perfect: an old animal, very nearly of the size of the Sumatran Rhinoceros.

No. 24. *Rhinoceros* —— ?—Lower end of radius right side, showing the articular surface with part of the shaft of very large size. Width of articular head being 5·7 inches: Antero-post. diam. 3 inches.

No. 25. *Rhinoceros* —— ?—Fragment of Os innominatum of large size.

No. 26. *Rhinoceros* —— ?—Axis, a good deal mutilated, showing the greater part of the body, but the apophyses broken off; posterior articular surface cup-shaped; odontoid process thick and massive: belonged to an animal of large size. In mineral condition and wearing this resembles some of the Perim Island fossils.

No. 245. *Rhinoceros* —— ?—Detached molar, very much worn and mutilated.

VII. ON THE FOSSIL RHINOCEROS OF CENTRAL TIBET AND ITS RELATION TO THE RECENT UPHEAVAL OF THE HIMALAYAHS.[1]

BY H. FALCONER, M.D.

THAT fossil bones occur on the Hīoondès or elevated plain of Tibet, at the northern face of the Himalayahs behind the sources of the Ganges has long been well known. They are brought to Almorah by the Bhoteah merchants, and sold as talismans or charms under the name of 'Bijli ki hār' lightning bones; ammonites, from the crests of the neighbouring snowy passes, called 'Chakar futteer' and venerated all over Hindostan as the sacred Salagram, are generally found mixed up with them. The occurrence of these organic mammiferous remains appears to have been first established by Captain Webb and Mr. Traill; but little or no attention has yet been paid to the determination of the species, the circumstances under which they are found, or the general results to which they lead.

Some of these fossils belong to a large species of Rhinoceros, others to a bovine ruminant, as large as the Indian wild buffalo; and when it is remembered that the bed of the Sutlej, where it flows through the Hīoondès or Steppe of Chāng-tang at a lower level than the situation of the stratum in which the bones are found, is elevated 15,000 feet above the sea, and that the natural vegetation at present hardly anywhere attains the size of a shrub—not to mention the Polar severity of the climate—it will at once be seen that the case involves important considerations regarding the physical changes which must have taken place in this part of the Himalayahs since the Rhinoceros remains were entombed in the stratum where they are now met with. But to give any value to the results, it is necessary that all the facts of the case be subjected to a rigid investigation.

[1] This interesting paper, which was probably written about the year 1839, is now for the first time published. Fragments of bones of fossil Rhinoceros and Equus, from the Niti Pass, are to be found in the British Museum, and are figured in the Fauna Antiqua Sivalensis, Plates lxxvi. and lxxxiv.—[ED.]

And, first, in regard to the fact of fossil bones occurring in the Hīoondès. No competent European observer has as yet seen them *in situ*. Moorcroft and Hearsay are the only travellers who have *traversed* the tract where they are said to occur. They went over the Niti Pass, and thence north across the plain of Chāng-tang by Dhapa to Gortope; thence eastward to the lake Manasarovara and back to Niti by another route along the Sutlej, the course of which they followed to Dhapa. Their journey embraced about a degree of longitude and latitude through the tract where the fossil bones are said to be found. But Moorcroft nowhere makes any mention of them; 'Bijli ki hār' are not even noticed in his narrative. He describes lofty gravel and clay precipices near Dhapa, and states his disappointment at not finding traces of marine remains in them. He also mentions having found abundance of ammonites at the Changlu river, under the Niti Ghati, on his return route. Captain Webb ascended to the crest of the Niti Pass and procured fossil bones brought from the plain of the Hīoondès, some of which, to be noticed in the sequence, are figured in Royle's Illustrations of the Botany of the Himalayahs, Pl. III. Mr. Traill,[1] in his Bhoteah and Kumaon reports, mentions the occurrence of fossil bones, and says they 'would appear to have belonged to some large animal of the ox species, probably the Yak.' He further states 'that the *Bijli ki hār* are chiefly found at the crest of the Niti Pass.' Mr. Batten, in his most graphic account of a visit to the Niti Pass,[2] says he advanced about two miles beyond the ravine of the Sianki river on the Steppe of the Hīoondès and came upon the Ammonite Fossil Ground. He subsequently mentions having 'a good many fossil bones from the interior of Tibet and the Mana Pass;' but it does not appear that he saw any of them *in situ*. The fact, therefore, of their occurrence still wants the important testimony of direct observation; but the other evidence to the point is so good as to leave no room for reasonable doubt on the subject. This evidence is as follows:

1. The concurrent statements of good observers, such as Webb, Traill, and Batten, supported by specimens, that fossil bones are found in the northern faces of the Niti and Mana Passes, and the Steppe of the Hīoondès.[3]

2. The direct testimony of the Bhoteah merchants who

[1] Asiatic Researches, vol. vii. p. 17.

[2] Jour. Asiatic Soc. vol. vii. p. 310.

[3] Mr. McClelland does not appear to have had an opportunity of examining these fossils, but he states that 'a skull, said to be that of an elephant, was brought down from a very high elevation to the Commissioner of Revenue in Kumaon, during my residence in the province; but not having inspected the fossil, I cannot answer for the fact.'—*Kumaon Inquiries*, p. 216.

bring the fossil bones to Almorah; they state that they are found in ravines in the plain below the Snowy Passes.

3. The universality of the belief at Almorah, where the *Bijli ki hār* are brought, that they come from the plains of Tibet, and from nowhere else.

4. The absence of any grounds tending to discredit the evidence in favour of the fact.

Next in regard to the geological features of the fossil tract. Mr. Batten,[1] from whom the most of what follows is derived, describes the rocks from the southern side up to the crest of the Niti Pass: talc and clay slates predominate near Malari; quartz rock, mica, schist, gneiss, and granite between Malari and Gumsali. The granite contains abundance of tourmaline and kyanite, as is the case all along the culminating axis of the mountains between the valley of the Spiti and the Eastern sources of the Ganges. Above Gumsali the road leads along granite and gneiss precipices. At Niti the formations appear to alter, clay slate rising into hills with a rounded outline, and a compact uncrystalline blue limestone succeeding the granite series, and higher up an arenaceous quartzose rock. From the source of Dhauli river to the crest of the pass the road leads up through crumbling of crags of blue limestone, the top of the pass being strewed with blocks of this rock and arenaceous quartz. The blue and mottled grey limestone here noticed has an extensive range of distribution all along the northern face of the Himalayah chain abounding in Ammonites, Terebratulæ, Belemnites, Zoophytes, &c., which have been met with in the valley of the Spiti by Dr. Gerard, at the head of the Ganges by Mr. Batten, and at Muctinath on the Gandaki river in Nepaul.[2] Several of the species have been determined by Mr. Sowerby not to differ from fossils of the English oolite. It is hardly necessary to add that this limestone has no other relation with the deposit which contains the fossil bones, besides contiguity of place.

The top of the pass, which is round and open, commands a view of the plain of Hīoondès. 'Right in front,' says Mr. Batten, 'stretched a dreary plain, shrubless, treeless, and houseless, terminated along its whole northern side, at a distance of about 20 miles, by a low range of rounded brown hills, utterly without shrub or tree or jutting rock, but very broken into ravines and perpendicular faces on their Southern side. Had there been heather instead of stone, it would have resembled a highland moor.' Its level was hardly anywhere lower than the pass. He further states his opinion that 'The Niti Pass

[1] *xii.* [2] Colebrooke, As. Research. vol. xii. Append. p. xxi.

is only the highest point of the Tartaric plain, running up to the Himalayah peaks.'

From the details given by Moorcroft, it is very clear that the upper stratum of this great plain consists of a deep alluvial deposit—whatever the age of the alluvium may be—composed of beds of clay and gravel. He was struck, on entering the country, with the broad flat channels of the rivers, bounded by lofty steep banks, as contrasted with the narrow angular beds on the Hindostani side of the mountains, being precisely the shape that would be washed out by a torrent running through soft unconsolidated strata. His description further gives good reason to surmise that the alluvium rises in successful steps like the parallel roads of Glenroy. He mentions broken ground with ravines near Dhapa, rising into pyramids and buttresses, 'bearing no unapt resemblance to ruined castles and fortifications in piles above each other.' A ravine near the Tiltil river yields a section of beds of indurated clay and gravel above 300 feet in elevation; the heights are broken into all manner of fanciful shapes, spires, buttresses, &c., the sides being excavated into habitations. There is but little variation from the above in his account of the country between Dhapa and Gortope, or between the latter place and the Manasarovara Lake, except at Tirthapuri, where he states that 'steep craggy limestone rocks in a state of decomposition immediately overhang it (the village). Still higher, and losing their heads in the clouds, are pointed mountains, which from their brilliant whiteness appear to consist of chalk, covered here and there with a layer of yellow ochre.' Near this spot he describes, in very characteristic terms, an enormous bed of travertine, forming a table of about half-a-mile in diameter, deposited from hot springs now in operation. At Kienlung he met with other great travertine deposits, perhaps not exceeded in extent by those hitherto observed in any other part of the globe. 'The vast walls and masses of rock which have been formed by the action of hot springs in this neighbourhood show an antiquity that baffles research and would afford food for sceptics.'

So much for the general geological features of the Hioondès plain. Of the particular beds which yield the fossils we have no accounts, besides the meagre details which may be gleaned from the Bhoteah merchants, who describe them as occurring in broken ground with ravines, upon the surface of which they are seen projecting or strewed over patches where the earth has been washed away by rills formed by melting snow. The specimens have rarely any of the matrix attached to them, but where it exists it is usually of coarse sand[redacted]ravel, agglutinated by a calcareous paste which efferves[redacted] with the mineral acids.

DESCRIPTION OF PLATE XV.

MERYCOPOTAMUS DISSIMILIS, FOSSIL RHINOCEROS OF NITI PASS.

Figs. 1 and 2. Represent the palatal and upper surfaces of the fragment of a young cranium of *Merycopotamus dissimilis*, from Burmah, sent by Dr. Oldham to Dr. Falconer. The figures are copied from drawings made by Mr. Dinkel for Dr. Falconer, and are one-third of the natural size. The palate surface shows the two last premolars and the two first true molars: *a*, cavity for anterior lobe of cerebrum; *b b*, frontal bones; *c c*, foramen in centre of frontal bone; *d d*, nasal bones; *f*, suture between nasal and maxillary bone; *g g*, maxillary bones. (See page 147.)

Figs. 3 to 11. Fragments of fossil *Rhinoceros* bones from the Niti Pass in Tibet, one-fourth of the natural size. Copied from drawings by Mr. George in Plate LXXVI. of the Fauna Antiqua Sivalensis. Figs. 3, 5, and 8 represent a fragment of the scapula, including the glenoid cavity and coracoid process; fig. 4 is a fragment of the left humerus near upper end; figs. 6 and 7 represent another fragment of a humerus; and figs. 9, 10, and 11 show a fragment of the lower end of a femur. The specimens are in the British Museum. (See pages 177 & 517.)

Judging from the quantities which find their way to Almorah, the fossils are by no means scarce. They are rarely seen entire, consisting generally of fragments three to six inches long; sometimes the contents of a collection are nothing but bits of bone hardly an inch long. They usually present a clean and sharp or splintery fracture, wearing the appearance of having been fragmented after the mineralization was complete. They vary greatly in the amount of fossilization, and, consequently, in specific gravity. The infiltrated mineral in most cases is carbonate of lime. The specimens adhere more or less to the tongue. In some of them the cancellated tissue has the cells entirely filled with the infiltrated mineral; in others the cells are empty. It is rare to see any tinge of iron about them, a character so prevalent in the Sewalik fossils of the arenaceous beds. One class of them has very much the appearance of bleached bones, with the fracture also white; their fossil character resting on a core of crystallized carbonate of lime and the increased specific gravity. In another class the specimens yield a dark blue fracture, and weather with very much of the greyish white leprous appearances which chalk fluids exhibit. They effervesce strongly with nitric acid, and treated with a weak solution of it, the greater portion of them dissolves; they retain few or no traces of animal matter.

Our materials for the elucidation of the species are but scanty. They are: first, a set of specimens in Captain Cautley's collection at Suharunpoor, received from Captain Corbet of Almorah; second, specimens received from Mr. Batten of Kumaon; third, specimens procured from a Bhoteah merchant, said to have been collected by himself on the Hīoondès; fourth, Pl. III. of Royle's 'Illustrations,' which contains some figures of fossil bones procured from the northern face of the Himalayahs by Captain Webb and Mr. Traill.

Rhinoceros Remains.[1]—These are, fortunately, very decisive. Fig. 3, Pl. III. of Royle's 'Illustrations,' represents the greater portion of a tooth evidently derived from a Rhinoceros, and probably the fifth or sixth molar left side of the upper jaw; but this is a point not to be determined by the figure, and we have not yet had access to the letter-press relating to it.

The next specimen is a fragment in Captain Cautley's collection, consisting of the left half of the body, with nearly the entire ala of the atlas or first cervical vertebra of a Rhinoceros. The upper and lower articulating surfaces are complete, and the bone is so characteristic as to leave no doubt about its identification. There is one remarkable circumstance about it, viz. that there is no hole for the passage

[1] See Plate xv. figs. 3 to 11.—[Ed.]

of the vertebral artery, the transit of that vessel to the head having been outside, and not through the bone. But this is merely an abnormal variation in the individual nowise affecting the species. The bone differs somewhat in form from that of the Indian Rhinoceros and is smaller, indicating a distinct species.

A second specimen in my possession happens also to belong to the left side of the atlas of a Rhinoceros. It shows more of the body but less of the ala than the other, and has the arterial hole in the usual position. The form of the bone and size confirm the distinctness of species indicated by Captain Cautley's specimen.

A third specimen is fortunately also very characteristic. It consists of a fragment of the left temporal bone, showing the posterior half of the zygomatic arch, the entire glenoid articulating surface, the external auditory foramen, a portion of the petrous bone and part of the temporal fossa. The styloid and petrous apophyses are broken off. It appears to have belonged to rather a young animal, as the commissure between the base of the zygoma and the petrous bone is not completely ossified. The fragment adheres to the tongue, and is but imperfectly fossilized. The characters yielded by it bear out the difference of species, indicated by the other specimens, between the Indian Rhinoceros and the Tibet remains. The glenoid articulating surface—a very characteristic structure—has a different outline from that of the Indian animal; the base of the zygomatic process has less vertical height in proportion, and the dimensions are somewhat less.

The collections contain other fragments referable to the Rhinoceros, but too much mutilated to afford any good character for description or comparison. There are no traces of any other Pachydermatous animal; but Elephant remains will probably be found hereafter, when the ground is well examined, if they have not been already met with.[1]

It is a point of much interest as regards the general bearing of the inquiry, to determine whether these Rhinoceros remains differ specifically or not from the fossil species of the Sewalik range; but the available materials, in both cases, are too imperfect to warrant any safe conclusions on the subject. It appears sufficiently clear, however, that the Tibet fossil species differ from the existing Indian Rhinoceros.

Ruminant Remains.—These are the most abundant in species and in the numerical ratio of specimens. Fig. 1, Pl. III. of Royle's 'Illustrations,' represents a very perfect cranium

[1] Vide M'Clelland's Kumaon Inquiries, quoted above.

Fig. 1.

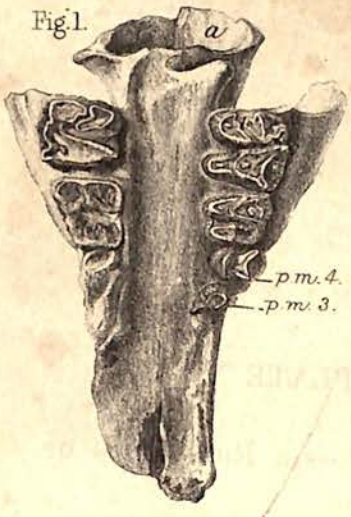


Fig. 2.

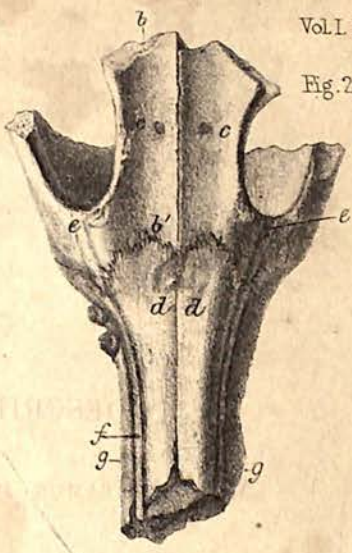


Fig. 3.

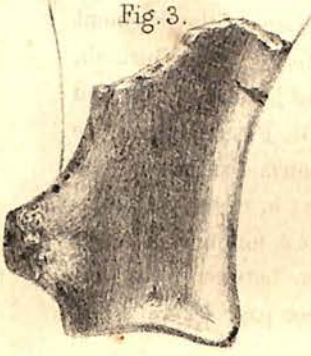


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

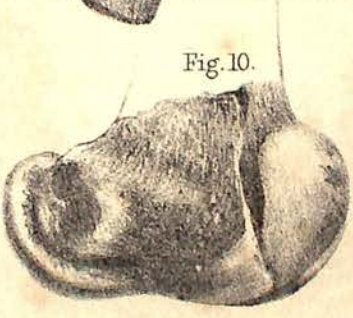


Fig. 11.

Dinkel & George del. J. Dinkel lith.

W. West imp.

1, 2. Merycopotamus dissimilis, from Burmah.
3 to 11. Fossil Rhinoceros, from Niti Pass, in Tibet.

of a ruminant with the pedicles of a couple of horns attached to the frontal. The saliency of the occipital crest, the sweep of the parietals and the position of the horn pedicles show that it belongs to the Cervine group of the family. But not having the letter-press to refer to, and in ignorance of the scale of dimensions on which the figure is drawn, it were useless to hazard or guess about the affinities of the species.

Fig. 2 of the same plate represents the left line of molars of the upper jaw of a ruminant. Judging from the figure, which shows no internal pillar between the barrels of the molar, the specimen belongs to the Caprine group.

In Captain Cautley's collection there is a specimen of the articulating head of the lower end of a femur of a bovine species. The dimensions fore and aft, between the articulating extremities, are six and a-half inches, exactly equal to the corresponding measurement of a full-sized wild buffalo (*B. Arna*) killed in the Shahjehanpoor forests. The existing Yak of Tibet is a much smaller animal. Another specimen in the Suharunpoor collection is the fragment of a scapula, corresponding in size with the femur. There are numerous other fragments of ruminant remains in the Suharunpoor collections, but none of them sufficiently characteristic to merit mention, except the detached core of a twisted sheathed horn belonging to some member of the Caprine group. The horn which it bore must have been twisted on its axis, like the 'Markhor' wild goat of the Baltistan Mountains (Little Tibet), a large and undescribed species.

There are no remains in the collection which can safely be referred to other mammiferous families except a solitary and detached Hyæna tooth procured from the Bhoteah merchant. It appears to be the third molar of the upper jaw, and is of large size. The whole of the specimens of this set are very much fragmented. They are white and have a very recent appearance, but they have lost their animal matter, have a considerable specific gravity, and the tubes of the cylindrical bones are occupied by crystallized cores of carbonate of lime, affording strong presumption of their being honest fossils. The Hyæna molar in question has the pipes of the fangs and the centre of the tooth filled with a nest of calcareous crystals.

This concludes what specially regards the determination of the fossils. It is very evident that the list is incomplete, for on a tract which could afford sustenance and a climate suited to the Rhinoceros a great variety of species might be expected. In what follows we put aside the consideration of the others, and address ourselves to the Rhinoceros.

The Steppe of Hīoondès has been shown by Captain Webb to be upwards of 15,000 feet above the sea, close on the limit of perpetual snow; it is bounded on one side by the Himalayah Mountains, and on the other by the Kailasa range, of enormous height, some portions being, on a rough approximation, 30,000 feet above the sea. The tract, in the emphatic language of Batten, is shrubless and treeless—a vast waste supporting a few furzę bushes and a sprinkling of the most Alpine vegetation; and the climate is one of Polar severity.

It is very certain that no Rhinoceros of the present time could exist for a day in such a habitat; and if we suppose the Tibetian species to have been clothed with a dense fur, like the Siberian species the carcase of which was brought to Pallas from latitude 64° on the banks of the Lena, still the tract could never have subsisted it, for although it has been urged by Dr. Fleming that the simple analogy of anatomical structure in the living species is not sufficient to guide us to a conclusion, or even a conjecture, as to the habits, geographical distribution, or food, of extinct species, so clearly shown in the lichen food of the Reindeer, still there is a limit to the force of this objection, and it only applies to certain cases. In the case of the Rhinoceros the incisive teeth are deficient in number, and the greater portion of them rudimentary in form and even deciduous. It may, therefore, be very safely predicated of all the species, fossil or existing, that they could never subsist by browsing on a herbaceous vegetation; they want the *nippers* which enable the horse and ruminants to subsist on low grass; and their food must either be derived from large reeds, shrubs, or trees, none of which are now found in Tibet.

The Siberian Rhinoceros remains are found on the shores of the frozen ocean, under conditions of climate more severe than those of Tibet; and it has been shown by Lyell how these remains might have found their way by changes in the physical geography of Siberia, by transportation in ice blocks, and by periodical migrations. But these conditions will not apply to the Hīoondès; the Rhinoceros could neither have migrated to its mountain-locked plain, from the side of Hindostan by the passes, where men and goats can hardly find their way save by the artificial aid of scaffoldings, nor is it apparent how the bones could have been transported to their present resting place from a higher tract.

The only explanation of the case that suggests itself, which appears admissible, is a depression of the plain of the Hīoondès to a much lower level than it has at present; and to clothe it with a vegetation resembling that of England now,

which, on the supposition that the Rhinoceros was not a migratory visitor but a permanent resident of Tibet, and clothed in a warm fur, is perhaps the utmost limit that could safely be conceded for its habitat. The plain of the Hīoondès would require to have been not higher than 7,000 or 8,000 feet above the level of the sea. The mean level of the Hīoondès which is known at Dhapa to be 15,000 feet, and estimated to be not much less than 17,000 near Manasarovara, may be considered as 16,000 feet. To reduce it, therefore, to the circumstances above inferred would involve the consequence that the northern face of the Himalayahs and (as elevating movements are nowhere known to be confined to narrow belts), probably a considerable portion of the chain itself, have been elevated 7,000 to 8,000 feet since the tract was tenanted by a species of Rhinoceros and several ruminants allied to existing species.

There are unquestionable proofs on the southern side of the chain that important elevations have taken place within a very late period, geologically speaking. The Sewalik formations are continuous with the Himalayahs, constituting in physical confirmation but the outermost belt of the chain. They bear, in fact, the same relation to the southern face that the Steppe of Hīoondès does to the northern. The fossiliferous strata attain a height of about 3,500 feet above the sea, and some parts of the belt about 5,000, the plains at their foot being about 1,000. These strata have not only yielded numerous extinct mammalia, but, besides Quadrumana and Camels, they have been shown to contain the remains of at least two existing species of Crocodile, viz. the Magar and Gharial, so common all over India; and the fluviatile shells (to which the testaceous remains are limited) have been pronounced by Mr. Benson not to differ specifically from recent types, common in the northern part of Hindostan.[1] This would show the upheavement, beyond all question, to date, geologically speaking, *since the commencement of* the present order of things; and if so grand a movement has occurred on the southern side of the chain within a late period, there is no reason why a similar upheavement should not have taken place on the Northern face.

Mr. McClelland has found proofs that a movement of elevation has taken place in the opposite prolongation of the chain in the valley of the Brahmapootra, in a marine deposit of considerable height abounding in shells on the Kasia hills. We are not informed what proportion of recent species has been found in these shells, and consequently, as to the age of the formation.

[1] Stated on the authority of Mr. Everest.

If it is admitted that there are good grounds for the belief that the plain of the Hīoondès has been elevated several thousand feet within a late period, it is necessary that we should consider what further consequences are involved in the supposition, and it will be evident that the entire line of mountains from the Lake Manasarovara to the southern bend of the Indus near Gilgit, in the parallel of Attock, must have partaken in the movement. For as the course of rivers from Manasarovara is due west, through a long intramontane tract, had the Hīoondès been 7,000 feet lower than it is now, and the western prolongations of the river beds not been proportionally depressed, the waters would have been held up, and we should have traces of vast lacustrine formations somewhere along the course of the Sutlej and Indus in Ladakh, which, so far as our information at present goes, does not appear to be the case. But as the great water-head of the western and eastern drainage of the Himalayahs is in the neighbourhood of Manasarovara, it is quite philosophical to imagine that the centre and greatest force of the upheavement was at the culminating point, and gradually decreased westward.

That upheavement of the southern face of the Himalayahs was in this manner is almost susceptible of direct proof. The Sewalik hills run west skirting the foot of the Himalayahs, beyond the western banks of the Jhelum; and the characteristic Sewalik fossils have been dug out of the strata between the Jhelum and Chenab, near Bimber, where they exist in abundance; they are also found between the Ganges and Gogra, and it is almost certain that the formation extends at least as far as the Gogra, giving a protraction in length of 270 miles, between the Jhelum and the Gogra. The greatest height of the fossiliferous strata is between the Jumna and Ganges, the elevation diminishing westward. It is, therefore, a matter for inference that the greatest force of the upheavements was at the culminating point, and was feebler as it extended westward.

It is a matter of much interest to determine whether these upheavements of the northern and southern faces were contemporaneous events. There do not appear any good grounds for coming to a satisfactory opinion on the subject, but there can be very little doubt that they belonged to the same geological era.

With these undoubted proofs (in the Sewalik hills) before us of comparatively late uprisings of the Himalayah mountains, it naturally occurs to the mind to inquire if the chain has been in a state of quiescence, as far as level is concerned, since the historical period, and if it is so in our own times.

The proof is embarrassed with immense difficulties in all mountainous tracts at a distance from the sea, which alone affords a certain standard for comparison; and this difficulty affects the central portion of the Himalayahs. But we shall endeavour to show that there are grounds sufficient for entertaining the presumption at least, that the Himalayahs are now undergoing a process of upheavements.

In Mr. Traill's excellent report on the Bhoteah Mehals, or region of the Tibet passes, occurs the following passage, which is so important to the point that it is given at full length.

'The paths to the passes' (the Mana, Niti, Juwar, Darma, and Beeans passes) 'continue along the upper part of the rivers above mentioned, till near the crest of the ridge, which is crossed in parts offering least difficulty in the ascent, and it is here only that snow is not met with during the season of intercourse. Roads of communication through the Himalayahs unite the passes from East to West, but they are passable during a few days only in each year, and are considered at all times dangerous by the Bhoteahs themselves. *Roads of this description formerly used are now impracticable, owing to the increase of snow.* The interior of the *Himalayah, except at the passes and paths in question, is inaccessible, and* APPEARS TO BE DAILY BECOMING MORE SO FROM THE GRADUAL EXTENSION OF THE ZONE OF PERPETUAL SNOW. *The Bhoteahs bear universal testimony to the fact of such extension, and point out ridges now never free from snow*, which, within the memory of man, *were clothed with forest* and afforded periodical pastures for sheep; *they even state that the avalanches detached from the lofty peaks occasionally present pieces of wood frozen in their centre.*'

Now these statements are of much importance, and their value is enhanced by the circumstance of their coming spontaneously from an unprejudiced inquirer. Mr. Traill attempts no explanation; he simply records the proofs and the universal belief that the zone of perpetual snow is descending lower. It is true that, before any conclusions could be safely drawn from them, the asserted facts will require to be verified and the observations extended, but they are at present sufficiently plausible to justify some speculations on the subject.

The circumstance of most weight is the assertion that pieces of wood are found frozen in the centre of the avalanches detached from the lofty peaks. Now it is very evident that this could only happen by a descent of the perpetual snow zone upon tracts where forests once grew, for it is difficult, if not impossible, to imagine how pieces of timber could at such enormous elevations be transported from below, so as to be

embedded high above in a mass of snow. But a descent, so to speak, of the snow zone could only occur in two ways, either by the line of perpetual snow being actually lowered to the level of the sea, or, supposing it to maintain a constant mean height, by an elevation of the mountain belt into the snow zone; either of which would produce, in appearance, the same effects.

Now, in regard to the first supposition of the lowering of the line of perpetual snow, the conditions which regulate the limits of that line are only very imperfectly understood, but it may safely be asserted that there are no grounds to believe, so far as our knowledge at present goes, that it oscillates more than the mean temperature of a place does; and the variation in this case does not extend beyond a few degrees of Fahr. Humboldt found that in the Andes, under the crater, the oscillation of the line of perpetual snow does not exceed thirty fathoms. In the Himalayah Mountains the present elevation of the line of perpetual snow is a huge anomaly, the plane being upwards of an English mile in excess of the amount yielded by calculation, with a formula for the latitude and height above the sea.[1] If, therefore, we suppose that the pieces of timber mentioned by Mr. Traill got enveloped in an avalanche by a lowering of the zone of perpetual snow, it would necessarily be implied that the plane of congelation was formerly more elevated, and would involve a still greater irregularity than the enormous extent at present ascertained, a position which it would be unphilosophical to admit, except on the strongest grounds.

On the second supposition, that the mean altitude of the plane of congelation is nearly constant, and that the mountains have been elevated into the snow zone, the instance of the enveloped timber would admit of two explanations; either that it belonged to the age when the Himalayah Mountains had their elevation increased by the Sewalik and Tibet upheavements or that the tract on which it grew had been subsequently raised up into the zone of congelation. That these mountains, before their summits attained their present elevation, were clothed with forests high up on the tract which is now covered with perpetual snow, is but consonant with the course of nature to suppose; and wood once enveloped in a snow bed would retain a freshness unimpaired for countless ages; we might, therefore, in a piece

[1] Perpetual snow level Niti Pass, Lat. 31° . . . . Feet 17,000
Calculated height of ditto by Professor Leslie's formula for Lat. 31° 11,253
Difference . . . . . 5,747 feet

of green wood, which descended from the higher peaks in an avalanche, light upon a remain which had a contemporaneous existence with the Sivatherium in Hindostan, or the Rhinoceros in Tibet; and it would be a matter of extreme if not insurmountable difficulty to determine to what period of the interval between these upheavements and the present time its envelopment in the snow should be referred.

The other circumstances mentioned by Mr. Traill, viz. that roads of communication from E. to W., between the passes formerly used, are now impracticable; that the zone of perpetual snow is gradually extending; and that ridges which, within the memory of man, were clothed with forest and afforded periodical pasture for sheep, have an obvious and important bearing on the question.[1]

[1] *Memoranda from Mr. Edgeworth, extracted from Dr. Falconer's Note-book.*—'1. On the Vishnoo Gunga, between Bhadra Nath and Pundoo Kesur, there is an artificial mound, at a place called Kutlean Kotee, which the Puharees say is the remains of a large hill city, that became deserted in consequence of the increased cold or descent of the snow zone. Charcoal and remains of pottery are found in it, and Edgeworth says the mound is, beyond all doubt, artificial. 2. There is a current tradition that formerly there was a straight path between Bhadra Nath and Kedar Nath, which has become impassable, so that a detour of several days is now necessary.—3. There was formerly a pass up the Bhillung river, which led into Tibet. It was last crossed more than fifty years ago, during the Goorka first invasion. Since then an attempt was made to cross it, but the party, of whom Edgeworth's informant was one, were struck with snow-blindness and nearly lost, so that they had to return.'—[Ed.]

VIII. ON THE FOSSIL EQUIDÆ OF THE SEWALIK HILLS.

No memoir on the fossil Equidæ of India was ever published by Dr. Falconer. Six new species are figured in the 'Fauna Antiqua Sivalensis,' two of which are from the Sewalik hills, viz. *Equus Sivalensis* and *Hippotherium Antilopinum*, the latter presenting the form of a horse with the attenuated proportions of an antelope. Two other species, *Equus Namadicus* and *Equus Palæonus*,[1] are from the valley of the Nerbudda, and there are two doubtful species from Ava and the Niti Pass. The reader is referred to the descriptions of the Plates in the Fauna (LXXXI. to LXXXV.) and to a memoir on sub-Himalayan fossils by Messrs. Baker and Durand, published in the 'Journal of the Asiatic Society' for October 1835, vol. iv. p. 568, and also to the following extracts from the catalogue of the Museum of the Asiatic Society in Calcutta.—[ED.]

DESCRIPTIONS BY DR. FALCONER OF FOSSIL EQUIDÆ IN THE MUSEUM OF THE ASIATIC SOCIETY OF BENGAL.

A. From the Sewalik Hills.

No. 303. *Equus Sivalensis.*—Fine specimen, connected by matrix to another fossil comprising both horizontal rami of the lower jaw from behind the molars on to the middle of the symphysis, in two pieces; the rami united by their inferior border to the shaft of a rhinoceros humerus, leaving their sides and the lines of molars free and in relief.

The whole series of six molars is present on either side, adult and well-worn but not aged, those on the right side having little matrix on the crowns of the first four; the two backmost, more or less covered, as also the greater part of the crowns on the left side. The left ramus is depressed somewhat by a crush below the level of the right. The teeth resemble in size and pattern of crown those figured in the Faun. Antiq. Sival. Pl. LXXXII. fig. 2. The front fragment passes nearly through the middle of the symphysis, showing in section the included portions of two canines, one on each side. The jaw is nearly the size of that of an English horse cranium in the Asiatic Society's Museum,

[1] At page 22, the specimens of *Equus Palæonus* are erroneously stated as being derived from the Sewalik hills. According to M. Lartet, *E. Palæonus* is probably the young individual of either *E. Sivalensis* or *E. Namadicus*. See note 2, p. 22.—[ED.]

the principal difference being that the height of the diastemal portion is greater in the fossil.

The following are the principal dimensions.

Extreme length of the fragment	13·6
Depth of jaw behind the last molar	5·1
Ditto in the middle	3·8
Ditto at commencement of diastema	2·6
Length of 6 molars	7·1
Length of diastemal portion	2·3

No. 304. *Equus Sivalensis.*—Lower half of left femur, attached by the anterior surface longitudinally to the shaft of the humerus of the rhinoceros, No. 302. (See page 170.) Shows a portion of the shaft, both condyles, the rotular pulley and the characteristic pit on the shaft above the outer condyle. Probably belonged to the same animal as the jaw.

No. 305. *Equus Sivalensis.*—Fragment comprising the symphysial portion of the inferior maxilla, broken off on the right side close to the symphysis, the greater part of the diastema remaining on the left, presenting the six incisor teeth *in situ* of a young adult (say five or six years old) the permanent teeth being all out; and the bases of the cups of the central incisors not yet worn off, the middle ones being large; unluckily the crowns of all these teeth have been more or less injured by attrition, and the form of the outer incisors is not seen, except that there is a rather deep vertical groove upon the inner and posterior surface of the outermost differing from what is seen in the English horse. A shallow vertical furrow is also seen upon the outer surface of the two outer incisors. The size of the specimen corresponds very closely with that of the same parts in the English horse cranium compared with No. 303.

No. 306. *Equus Sivalensis.*—Lower end of femur, right side, showing the condyles and articular surfaces nearly entire, with a small part of the shaft attached. The condyles are quite entire, and the inner border of the rotular pulley presents the characteristic large salient projection.

No. 307. *Equus Sivalensis.*—Fine fragment comprising part of the horizontal ramus right side, broken off immediately behind the last molar and in front through the posterior half of the third premolar; showing three entire teeth, and part of a fourth, viz. the three true molars and last premolar; the last molar is only partially worn, showing the animal to have been a young adult. The size and pattern of the crown agree very closely with the specimen No. 303. The fossil is black, hard, and heavy, and the teeth finely preserved. The large flexures of the enamel plates well shown.

No. 315. *Hippotherium Antilopinum.*—Lower end of radius, right side.

No. 316. *Hippotherium Antilopinum.*—Fragment comprising the carpus, left fore-leg, and metacarpals united in the natural manner, the metacarpus broken about the middle of the shaft; the upper part of the lateral metacarpals shown. Of small size.

No. 369. *Equus Sivalensis.*—Lower end of right humerus, showing only the articulating head somewhat crushed, and therefore doubtfully determined, but in the absence of the third pulley agreeing with Horse.

No. 391. *Equus Sivalensis.*—Articulating head of right humerus very perfect, but detached from the shaft.

No. 676. *Equus Sivalensis.*—Mass of matrix containing calcaneum of *Equus Sivalensis* with two vertebræ adhering.

No. 696. *Equus Sivalensis.*—First cervical vertebra (atlas). A fine specimen, nearly entire, and nearly of the same proportions as in the existing horse, but the body somewhat shorter; the spinous tuberosity less prominent, and the posterior inferior margin free from a hitch or emargination. The specimen is only defective in the marginal expansion of the transverse processes, where the edge is broken off.

No. 697. *Equus Sivalensis.*—Fourth cervical vertebra. Body nearly entire, processes more or less mutilated.

No. 698. *Equus Sivalensis.*—Fine specimen of the sixth cervical vertebra. Body entire; neural arch broken off; inferior transverse process on left side entire and very broad and massive, more so than in the recent horse; broken off on right side.

No. 700. *Equus Sivalensis.*—Very fine specimen of the third cervical vertebra; the body nearly entire, and formed closely, as in the existing horse, with the same broad expansion of the transverse processes delated posteriorly; the lips of both superior and inferior transverse processes together with the neural arch broken off. The form generally resembles that of the same bone in the 'Nyl Ghau;' but it is at once distinguished from the ruminant type by long and nearly concealed vertebral foramina, the entrance of the artery being close to the margin of the spinal canal.

No. 701. *Equus Sivalensis.*—Seventh cervical vertebra. Body nearly entire, neural arch present, but spinous process broken off; distinguished by the absence of a vertebral foramen; a costal articulation shown on one side of the posterior surface; closely resembles the same bone in the recent *Eq. Caballus.* The anterior articulating surface broader.

No. 702. *Equus Sivalensis.*—Fifth cervical vertebra. Body nearly entire; posterior articular surface having the lateral margin broken on the left side; neural arch present; spinous axis styles broken off. Vertebral canal with a very large opening; a good deal of matrix on the specimen.

No. 705. *Equus Sivalensis.*—Mutilated astragalus.

No. 706. *Equus Sivalensis.*—Proximal phalanx; fore-leg, of small size, nearly entire.

B. From Perim Island.

No. 34. *Equus.*—Upper jaw, left side, containing the two anterior premolars, well worn, corresponding in characters with *Eq. Sivalensis*, Faun. Sival., Pl. LXXXII.

No. 35. *Equus.*—Astragalus, small size.

No. 36. *Equus.*—Lower jaw, left side, containing the four anterior molars, well worn; truncated in front and behind; agrees with No. 34.

No. 37. *Equus.*—Lower jaw, right side, containing the three anterior molars, with portion of the diastema in front, and truncated behind.

No. 66. *Equus.*—Atlas of a very small-sized horse—*Hippotherium Antilopinum?* Faun. Ant. Siv.

No. 67. *Hippotherium Antilopinum.*—Axis, nearly entire, inferior cup wanting; corresponding in size to No. 66.

No. 68. *Hippotherium Antilopinum.*—One of the middle cervical vertebræ, with only the superior oblique process, left side, and body otherwise much mutilated.

No. 85. *Equus.*—Left calcaneum, nearly entire, of small-sized species.

No. 100. *Equus.*—Lower end of humerus with inner half of articulating surface broken off.

No. 111. *Equus.*—Fragment of upper maxilla, right side, containing the penultimate and the next two adjoining anterior molars; the crown covered by matrix, but of the size of No. 34.

C.

[Specimens of fossil 'Equus' from Ava and the Nerbudda are also described by Dr. Falconer in the Catalogue of the Asiatic Society.—Ed.]

Manuscript Note by Dr. Falconer.

	Horse, large Sewalik specimen		Horse, large Nerbudda specimen	
	Length	Width	Length	Width
Extreme length of 6 molars . . .	7·5	...	7·	...
1st molar	1·7	1·1	1·6	1·0
2nd „	1·4	1·25	1·2	1·1
3rd „	1·2	1·2	1·1	1·2
4th „	1·1	1·1	1·	1·
5th „	1·2	1·15	1·05	1·
6th „	1·25	·9	1·25	·95

IX. ON SOME FOSSIL REMAINS OF ANOPLOTHERIUM AND GIRAFFE, FROM THE SEWALIK HILLS.[1]

BY H. FALCONER, M.D., AND CAPT. P. T. CAUTLEY.

In continuation of their former researches on the fossil remains of the Sewalik hills, the authors, in their present communication, establish, on the clear evidence of anatomical comparison, certain discoveries which, in previous publications, they had either merely announced, or had supported by proofs professedly left incomplete. They now demonstrate that there occur in the remarkable tertiary deposits of the Sewalik range, together with the osseous remains of various other vertebrate animals, bones belonging to the two genera, *Anoplotherium* and *Giraffe*: the former genus determined by Cuvier from parts of skeletons dug out from the gypsum beds of Paris; the latter genus known only as one of man's contemporaries, until, in the year 1838, the authors gave reason for believing its occurrence in the fossil state.

The specimens now figured and described form part of the collection which was made by the authors on the spot, and is now deposited in the British Museum. They were found, together with remains of Sivatherium, Camel, Antelope, Crocodile, and other animals, in the Sewalik range to the west of the river Jumna.

The bones are found embedded either in clay or in sandstone. When clay is the matrix, they remain white; and, except in being deprived more or less completely of their animal matter, they have undergone little alteration. The bones in this state the authors have elsewhere designated as the 'soft fossil.' When sandstone is the matrix the animal matter has completely disappeared, and the bone is thoroughly

[1] The memoir, of which this is an abstract, was communicated to the Geological Society of London, on Nov. 15, 1843. The abstract and illustrations are copied from the 'Proceedings,' No. 98. The *Anoplotherium Sivalense* was afterwards described in a separate memoir, under the designation of *Chalicotherium Sivalense*, to which the reader is referred. Subsequently to the publication of this memoir, the bones of the anterior and posterior extremities of *Camelopardalis Sivalensis* were discovered, and were figured in an unpublished plate of the Fauna Antiqua Sivalensis. See descriptions of Plate E, and also appendix to paper.—[Ed.]

mineralized and rendered nearly crystalline by the infiltration of siliceous or ferruginous matter, and acquires a corresponding hardness, or tinge of iron, with increased specific gravity. The matrix in contact with the bone is rendered compact and crystalline in texture. The remains in this state have been designated by the authors as the 'hard fossil.'

The remains of *Anoplotherium* and of the larger species of Giraffe, described in the present communication, belong to the 'soft fossil;' those of the smaller species of giraffe to the 'hard fossil.'

Anoplotherium.—The occurrence, in the Sewalik deposits, of bones belonging to this genus, was announced by the authors in their 'Synopsis of the Fossil Genera from the upper deposits of the Sewalik hills,' published in vol. iv. of the Journal of the Asiatic Society of Bengal, in the year 1835; and the same fact was afterwards referred to in vol. vi. p. 358, of that journal. In these communications the species was not described, but was named provisionally, *A. posterogenium*. In a communication made to the Geological Society in the year 1836, descriptive of a quadrumanous fossil remain, and published in vol. v. of the second series of their 'Transactions,' the same species was mentioned under the name of *A. Sivalense*, a term which the authors propose to retain, in accordance with the principle they adopted in the cases of the horse, camel, hippopotamus, &c., of connecting the most remarkable new species of each fossil Sewalik genus with the formation itself.

In their present communication the authors purposely abstain from entering on the anatomical characters of this new species further in detail than is barely sufficient for its determination; and they therefore confine their notice to two fine fragments of one head, one fragment (Pl. XVII. fig. 1) belonging to the left upper jaw; the other fragment (Pl. XVII. fig. 2) to the right upper jaw.

By a happy chance the teeth are beautifully preserved. The age of the individual, which was just adult, was the best that could be desired to show the marks characteristic of the genus; for the teeth had attained their full development, though the two rear molars had hardly come into use.

Plate XVII. fig. 1, is a horizontal view of the left upper jaw comprising the six back molars. These teeth were subjected to a rigid comparison with a cast from the jaw of *Anoplotherium commune*, figured by Cuvier in vol. iii. of the 'Ossemens Fossiles' (Plate XLVI. fig. 2), and also with casts from the corresponding molars of *Chalicotherium Goldfussi*, figured by Kaup in the second 'livraison' of his 'Ossemens

Fossiles' (Plate VI. figs. 3–5 and 8–10), between the teeth of which two extinct quadrupeds those of the Sewalik fossil are intermediate in size. In general form and in the principal distinctive marks they agree closely with the teeth of the typical European species of Anoplotherium, as described by Cuvier; but they differ from those types in some particulars requiring special notice; they are closely allied to the teeth of the *Chalicotherium* of Kaup.

The three rear molars considerably exceed, in all their dimensions, the corresponding teeth of *A. commune*; and the two rear molars also differ from the corresponding teeth of *A. commune* in the following respect, that their width is greater than their length. This proportional compression lengthwise belongs to the last two pre-molars of the Sewalik fossil, and it holds also with the back molars of the *Chalicotherium*. The outer surface presents, both vertically and horizontally, the usual double chevron, or W-form of *Anoplotherium*, with the three salient vertical bulges swelling up from the base to the crown; but with this difference from *Anoplotherium*, that the surface of the re-entering angles is more inclined inwards. The latter point is one of agreement with *Chalicotherium*, in which the outer ridge of the crown is so inflected as to be brought into the middle of the plane of the tooth. The interspaces forming these re-entering angles are more unequal than in *A. commune*, the anterior one being much the broader. The posterior one in the last molar is placed very obliquely, sloping backwards and inwards. In these respects also the fossil agrees closely with *Chalicotherium*. The vertical bulges, more especially the rear one of the last molar, are slightly notched near the apex into a lobule of the enamel, but much less so than in *Chalicotherium*. In consequence of the progress of wear being more advanced in the two other back molars, they show no indications of this notch.

From the great inflection of the outer surface, the longitudinal ridge of the crown is strongly zig-zagged. The apex of the anterior re-entering angle gives off a transverse ridge, which is much inclined downwards, and joins on with the base of the isolated conical cusp (a, a', a'') in the anterior and inner corner of the tooth, a cusp characteristic of *Anoplotherium*. In the Sewalik species, as in *Chalicotherium*, this cusp is much larger, more pointed, surrounded by deeper hollows, and more in relief than it is in *A. commune*. It is even more developed than in *Chalicotherium*. The apex of the posterior re-entering angle gives off a like transverse ridge which sweeps round into the posterior side, and forms in the germ a sort of three-sided pyramid, connected by a

low ridge with the cusp. The anterior border of the crown is formed of a similar low ridge, sweeping round to the inner side of the cusp, upon which it terminates near the middle of the cusp. This ridge is less developed than in *A. commune*.[1]

The penultimate and antepenultimate are so like the last molar that the authors deem it sufficient to refer to the figures. The penultimate is the largest of the three, and the antepenultimate considerably the smallest. There is in all the three molars a strong development of the cusp; though, from the different stages of wearing, it shows differently in the several teeth. In the back tooth it is intact and has a sharp edge; in the penultimate the point is just worn off into a slight oblique facet; in the antepenultimate it is ground low down into a circular depressed disc, surrounded by a ring of enamel.

The other teeth in the specimen (Plate XVII. fig. 1) are the last three false molars. What was the entire number of this series, whether it extended to four, as in *A. commune*, or was limited to three, the specimen affords no certain indication. If there was a fourth tooth (which is most probable) it must have been in a rudimentary or reduced state, as in the rhinoceros, and must have been disconnected from the rest of the series by being placed somewhat forwards in a diasteme; for no indication is obtained, from the appearance of the anterior tooth, or from the remains of any alveolus, that there was another tooth close in front of the sixth. These three premolars, taken in succession from rear to front, diminish rapidly in size; and in the aggregate are much shorter than the same three teeth in *A. commune*, the joint length in the Sewalik fossil being 1·8 inch, whereas in the smaller jaw of *A. commune* it is 2·3 inches. In the latter, as is the case in the Ruminants, the anterior premolars are narrow and elongated; in the Sewalik fossil they are short and wide. This general condensation of the premolars adds to the probability of the existence of a vacant diasteme. All the premolars exhibit, in a well-developed form, the characteristic cusp. The posterior two have their outer surface flat or slightly convex; and they contract inwards towards the cusp in a sub-cuneiform shape, the cusp and inner side being bounded by a low basal ridge.

[1] *MS. Note by Dr. Falconer.*—'This low anterior ridge corresponds with the *anterior inner* crescent of *Anop. commune*. In the latter species, while the other three crescents are as perfectly developed as in the ruminants, the anterior inner lobe has only the front horn of the crescent, and never shows more than a narrow strip of ivory by wear. The reduction, which begins in *Anop. commune*, is carried still further in the Sewalik species; a rudiment of the lobe only appearing, while the conical tubercle is proportionally increased.'—[Ed.]

The antepenultimate premolar of the Sewalik fossil is somewhat different from the two others, being much smaller, and contracting upwards into a trenchant edge. The cusp is connected by a transverse ridge with the main ridge of the crown, and the basal ridge is reduced to a small mammilla in front of the cusp.

Plate XVII. fig. 2 represents the outside of the right upper jaw, comprising the four back molars, and is an exact counterpart, so far as it goes, of the left upper jaw.

There is little else shown by this specimen than what regards the teeth. The muzzle appears to have fined off rather abruptly in front of the malar protuberances, and the orbit to have been advanced more forward on the face, and to have been more depressed below the brow than in *A. commune*.[1] The upper orifice of the sub-orbital canal is seen opening behind the anterior angle of the orbit, the floor of which appears to have extended behind the post-orbital processes.

The dimensions, as compared with those of *A. commune*, and *Chalicotherium Goldfussi*, are as follows:—

	Ch. Goldfussi	*A. Sivalense*	*A. commune*
	Inches	Inches	Inches
Length of the series of 6 molars	7·1	5·5	5·5
Ditto 3 true molars	5·	3·7	3·2
Ditto 3 premolars	2·1	1·8	2·3
Length of the last true molar	1·85	1·3	1·2
Width of ditto	1·94	1·5	1·2
Length of the penultimate true molar	1·7	1·4	1·2
Width of ditto	1·9	1·55	1·1
Length of the antepenultimate true molar	1·3	1·1	1·
Width of ditto	1·4	1·1	1·1
Length of the last premolar	0·8	0·75	0·65
Width of ditto	1·15	0·88	0·75
Length of the penultimate premolar	0·6	0·70	0·90
Width of ditto	0·9	0·80	0·62
Length of the antepenultimate premolar	0·75	0·55	0·75
Width of ditto	0·5	0·55	0·50
Height of the last molar	0·87	1·1	0·65

These measurements show the Sewalik species to have been larger than *A. commune*, and smaller than *Chalicotherium Goldfussi*. One of the most striking points in which it differs from the two latter terms of comparison is in the dimensions of its back molar, which, with the same amount of wear, is about half an inch higher than in *A. commune*, and in this respect considerably exceeds even the longer and wider tooth of the *Chalicotherium*.

[1] See Ossemens Fossiles, tom. iii. tab. 57. fig. 1.

	Length	Width	Height
A. Sivalense	1·3	1·5	1·1
A. commune	1·2	1·2	0·65
Ch. Goldfussi	1·8	1·94	0·87

On the whole the Sewalik species appears to be most closely allied to the *Chalicotherium Goldfussi*. The existence of a vacant diasteme in front of the anterior tooth would constitute a difference from the Anoplotherian type of some importance. The characters generally show a return from the ruminant tendencies of the Cuvierian species back to a more pachydermatous type, and a closer affinity with the rhinoceros, between which and *A. commune* it may ultimately prove to be an intermediate form. Until the evidence for separation is conclusive the authors suggest leaving it with the genus Anoplotherium. The *A. commune* was determined by Cuvier to be of the size of a small ass; the *A. Sivalense* would rank in dimensions between a horse and the small Sumatran rhinoceros.

Remarks on Chalicotherium.—Kaup appears to have founded this genus, as distinct from Anoplotherium, on real or supposed differences, 1st, in the rear molars; 2nd, in the incisors; 3rd, in the canines. The difference in the rear molars consists in the size of the lobule of the enamel, into which the vertical bulges near the apex are notched; this character indicates, as he conceives, an affinity with the Tapir and Lophiodon. But this lobule, even if constant, does not appear to the authors of sufficient importance to constitute the basis of a generic distinction. The general form of the rear molars of both the upper and lower jaws is only an enlarged and less rectangular representation of those of Anoplotherium. Moreover, in the direction of the ridges of the crown, and in the insulation of the conical cusp, the accordance between Chalicotherium and Anoplotherium is complete. As to the second distinction, drawn from the supposed form of the incisors, the detached tooth which he figures and describes as a lower incisor (Oss. Foss. liv. ii. p. 30, Pl. VII.), judging from the figures and from a cast which the authors have examined, very closely resembles, both in form and in the development of the crown, the penultimate premolar of the *A. Sivalense*. The channeled sides and the bifid extremity of the fang, indicating two confluent fang roots, and the complicated form of the crown with three mammillæ on the inside, appear to the authors strongly to militate against regarding the tooth as an incisor. They therefore consider this tooth as an upper premolar (and probably as the penultimate) one of the right side.

As to the third distinction, drawn from the canine teeth, judging from a cast of the detached fragment which Kaup

describes and figures as the canine of *Ch. Goldfussi*, the authors consider that determination as problematical. It seems to them to bear a resemblance in form rather to the lower incisor of an animal allied to rhinoceros. They advance these doubts with the utmost deference to the distinguished author.

Remarks on the Genus Anoplotherium.—The true Anoplotheria of Cuvier (of which *A. commune* may be regarded as the type), together with the *A. Sivalense* and the *Chalicotherium* (Anoplotherium ?) *Goldfussi* are allied, by their dentition, to Rhinoceros. The Dichobunes, *A. leporinum*, *A. murinum* and *A. obliquum*, Cuvier arranges with considerable doubt, and provisionally only, among the Anoplotheria. He considers it not impossible that the two latter species were small Ruminants. The *A. cervinum* of Professor Owen (Geol. Trans. 2nd ser. vol. vi. p. 45), obtained by Mr. Pratt from Binstead in the Isle of Wight (Idem. vol. iii. p. 451), is admitted on all hands to be exceedingly like a musk deer. Such heterogeneous materials are too much for the limits of any one genus. Cuvier imagined the separation of the two metacarpal bones to be a character limited to the Anoplotheria exclusively. He has also regarded the union of the metacarpal bones as holding without exception in all the ruminants; and this law with respect to ruminants, though empirical, he regards as equally certain with any conclusion in physics or morals, and as a surer mark than all those of Zadig (Disc. Prél. p. 49).[1]

The authors, having had an opportunity of examining the skeleton of an African ruminant, the *Moschus aquaticus* of Ogilby, described in the 'Proceedings' of the Zoological Society by that gentleman from a living specimen, found it wanting in the above supposed essential character of the ruminants, and possessing the above supposed distinctive character of Anoplotherian Pachyderms. Its metacarpals are distinct along their whole length; its foreleg, from the carpus downwards, is undistinguishable from that of the peccary; and its succentorial toes are as much developed as in the last-mentioned animal.

The deviation from the ordinary ruminant type, indicated by the foot of this Moschus, is borne out by a series of modifications in the construction of the head and in the bones of the extremities and trunk, all tending in the direction of the pachyderms.

The authors believe the present to be the first announcement of the existence of such an anomaly in any living ru-

[1] See appendix to memoir on *Chalicotherium*, No. II.—[Ed.]

minant; they had previously ascertained the occurrence of the same structure in a fossil ruminant from the Sewalik hills. As the Dorcatherium of Kaup breaks down the empirical distinction between the ruminants and pachyderms, as regards the number of the teeth, so does the *Moschus aquaticus* as regards the structure of the feet.

Giraffe.—In the 7th volume of the 'Journal of the Asiatic Society of Bengal' (pp. 658–660) is a communication dated 'Northern Doab, July 15, 1838,' and intituled, 'Note on a Fossil Ruminant Genus allied to *Giraffidæ*, in the Sewalik hills, by Captain P. T. Cautley.' The specimen referred to in that paper was the third cervical vertebra of a ruminant, which, for the reasons therein assigned, was supposed to have been a giraffe. At that time the authors of the present communication had not access either to drawings of the osteology or to a skeleton of the existing giraffe; but the grounds for referring the vertebra to that genus were, that it belonged to a ruminant with a columnar neck, the type of the ruminants being preserved, though very attenuated in its proportions; that the animal was very distinct from any of the camel tribe; that it was in the giraffe that there existed such a form most aberrant from the mean in respect of its great elongation. That the bone belonged to a giraffe was put forth at the time as only a probable inference, and chiefly to serve as an index to future inquiries.

The authors, having since the former period obtained additional specimens, and had access to the fullest means of comparison, are now able to place on the record of determined Sewalik fossils one very marked species of giraffe, and also indications of a second species, which, so far as the scanty materials go, appears to come near to that of Africa.

The first specimen to which they refer is the identical vertebra noticed by Captain Cautley in 1838. (See Plate XVI. figs. 1–4.) It is an almost perfect cervical vertebra. It were needless to enter on the characters which prove it to have belonged to a ruminant. Its elongated form shows that it belonged to one with a columnar neck; that is to say, either to one of the camel and Auchenia tribe, or to a giraffe, or to some distinct and unknown type. The fossil differs from the vertebra of a camel, 1st, in the position of the vertebral foramina (a, a'); 2nd, in the obsolete form of the upper transverse processes. According to the masterly analysis of the Macrauchenia by Professor Owen, the *Camelidæ* and Macrauchenia differ from all other known mammalia in the following peculiarity: that the transverse processes of the six inferior cervical vertebræ are without perforations for the vertebral

arteries, which enter the vertebral canal along with the spinal cord, then penetrate the superior vertebral laminæ, and emerge on the canal again close under the anterior oblique processes. This structure appears in the cervical vertebræ of the Sewalik fossil camel. In the vertebra now under consideration, on the contrary, the foramina (*a*, *a'*) maintain their ordinary position, that is, they perforate the transverse processes, and appear on the surface of the body of the vertebra.

Since the bone therefore does not belong to a camel, is it the bone of a giraffe? There is preserved in the Museum of the Zoological Society the skeleton of a young Nubian giraffe which died at the Society's gardens. When its third cervical vertebra is placed in apposition with the fossil, the two are found to agree in every general character, though they disagree in some of their proportions, and in certain minor peculiarities. In this young and immature giraffe the length of the third cervical vertebra is 7½ inches; what, then, is the length of this bone in the adult Nubian giraffe? The authors, from their not having had under their examination this vertebra from an adult animal, have been unable to ascertain this point directly; but they are able to infer it, from the length of a detached bone preserved in the Museum of the Royal College of Surgeons of London, which is the second cervical vertebra of a giraffe, nearly, but not quite, full grown.[1] The length of this bone is 11½ inches. Now in the skeleton of the young giraffe belonging to the Zoological Society the 2nd and 3rd cervical vertebræ are exactly of the same length. The authors infer, therefore, that in an animal nearly full-grown, such as was that to which the detached bone at the College of Surgeons belonged, the length of the 3rd cervical vertebra is 11½ inches; and consequently, that the length of the same bone in an animal which has reached full maturity is about 12 inches.[2]

That the fossil vertebra belonged to an adult which had long attained its full size is shown by the complete synostosis of the upper and lower articulating surfaces, by the strong relief of the ridges and the depth of the muscular depressions. But the length of this bone is only a little more than eight inches. As the other dimensions of the fossil and recent vertebræ that the authors placed in apposition are nearly in proportion to their respective lengths, it follows

[1] This appears from the detached state of the upper and lower articulating heads of the bone.

[2] The height of the skeleton of the young giraffe in the museum of the Zoological Society is 10½ feet; that of a full-grown Nubian giraffe is 16 feet.

that this fossil species of giraffe was one-third shorter in the neck than an adult of the existing Nubian variety.

But it was not only in size that the two giraffes differed: they differed also in their proportions. In the young giraffe at the Zoological Society the vertebra, which is 7½ inches long, has a vertical diameter of 3·8 inches; whereas in the fossil species the vertebra, which is 8 inches long, instead of having a vertical diameter exceeding 4 inches (as it ought, if its breadth were proportional to its length), has a vertical diameter of only 3·6 inches. This goes to prove that in this fossil giraffe the neck was one-tenth more slender in proportion to its length than the neck is in the existing species.

The inferior surface of the body of the vertebra is more curved longitudinally in the fossil than it is in the recent bone; the height of the arc in the former case being to the height in the latter as 3 is to 2.

On the under surface of the fossil vertebra a very distinct longitudinal ridge (*b*) runs down the middle, and this ridge is wanting in the recent bone; but this difference, probably, is chiefly owing to difference of age.

In the fossil vertebra the upper articulating head (*c*) is very convex; for with a transverse diameter of 1·4 inch it has a vertical height of 1 inch; laterally it is a good deal compressed.

The posterior articulating surface (*d*) forms a perfectly circular cup, two inches in diameter; and this diameter, in the immature Nubian giraffe, is one-tenth greater, although the vertebra is one-sixteenth shorter. This affords a further proof of the comparative slenderness of neck in this fossil species. (See Plate XVI. fig. 4.)

In regard to the apophyses, the inferior transverse processes (*i*, *i*) are sent off downwards and outwards from the lower part of the anterior end, exactly as in the recent species, and they are developed to nearly the same amount of projection. There is, however, this considerable difference, that whereas in the recent species they do not run half-way down the body of the vertebra, in the fossil they are decurrent along the whole of its length in well-marked laminar ridges, which are confluent with the nearly obsolete ridges of the upper transverse processes, the united mass near the posterior end being dilated into two thick alæform expansions (*e*, *e*).

In the fossil, as in the recent bone, the superior transverse processes are seen only in a rudimentary state; in the former, however, they run forwards across the body with less obliquity, and consequently make the canals for the

vertebral arteries twice as long as they are in the recent bone. In the fossil the orifices (*a*, *á*) of these canals divide the length of the vertebra into three nearly equal portions; whereas in the recent bone the orifices are both included within its anterior half.

The anterior oblique processes (*f*, *f*) have the same general form and direction both in the fossil and recent species; but in the former they are considerably stouter and larger, and their interspace is less. The articular surfaces are convex, and are defined exactly as in the recent species.

The posterior oblique processes (*g*, *g*) of the fossil differ in form very little from those of the recent bone; in the fossil, however, the articular surfaces are considerably larger; and the ridges in which they are continued along the side of the upper vertebral arch are much less convergent than in the recent bone; so that in the latter this part is somewhat heart-shaped; whereas in the fossil it is nearly oblong, and 'looks squarer,' so to speak.

The spinous process (*h*) in the fossil is the same thin triangular lamina that is seen in the recent species; and it differs only in having its most prominent point lower down on the arch.

The spinal canal is very much of the same form and dimensions in both the fossil and the recent vertebra. At this point some of the matrix remains attached to the fossil bone, and prevents any very precise measurement.

As a minor point of agreement between the fossil and recent bones, it may be noted that, in both, the foramen (*k*) for the small nutritious artery on the inferior side of the body of the vertebra is on the right. In the other cervical vertebræ of the recent skeleton this solitary foramen is on the left.

From the above comparisons it appears that the fossil vertebra, while it is very distinct from that of a camel, fulfils all the conditions required for a strict identification with that of a giraffe; that its peculiarities are not of greater than specific importance; and consequently do not warrant its being referred to a distinct and unknown type among the ruminants.

The following are the dimensions, in detail, of the third vertebra in the adult Sewalik fossil and in the immature Nubian giraffe, 10½ feet high, in the Museum of the Zoological Society:—

DESCRIPTION OF PLATE XVI.

CAMELOPARDALIS.

Figs. 1 to 4. Third cervical vertebra of *Camelopardalis Sivalensis*, one-half of the natural size. Copied from drawings by Mr. Scharf in No. 98 of the Proceedings of the Geological Society, and by Mr. Dinkel in an unpublished Plate of the Fauna Antiqua Sivalensis. The specimen is in the British Museum; Cat. No. 39,760. *a á*, orifices of the arterial canals; *b*, longitudinal ridge on the underside of the body; *c c*, upper articulating head; *d*, lower articulating surface; *e e*, alæform expansions of the transverse processes; *f f*, superior oblique processes; *g g*, inferior oblique processes; *h h*, spinous process; *i i*, inferior transverse processes; *k*, foramen of the nutritious artery. (See pages 197 & 543.)

Figs. 5 *a* and 5 *b*. Views in plan and profile of the last two upper molars of *Camelopardalis affinis*, one-half of the natural size. This as well as the succeeding figures, copied from No. 98 Proc. Geol. Soc., Pl. II.

Fig. 6. Last upper molar, right side, of *Camelopardalis affinis*, one-half of natural size.

Fig. 7. Last lower molar, left side, of ditto, one-half of natural size.

Fig. 8. Last lower false molar, left side, of ditto, one-half of natural size.

Fig. 9. Second upper false molar, right side, of ditto, one-half of natural size.

Fig. 10. Rugose reticulated surface of the enamel of upper molars of ditto, magnified to twice the natural size. (See page 202.)

Fig. 1.

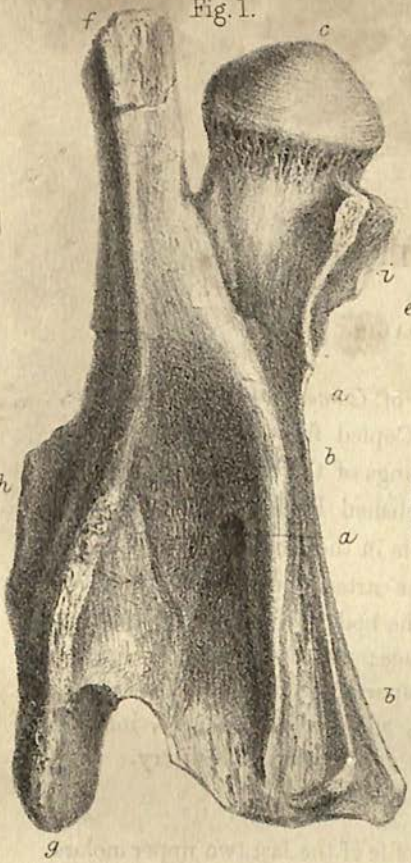


Fig. 4.

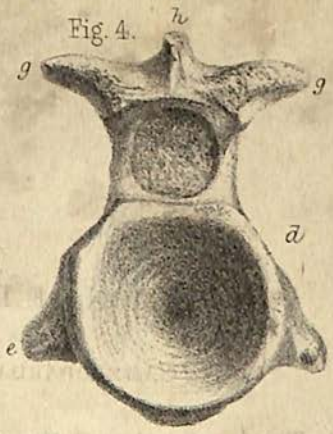


Fig. 3.

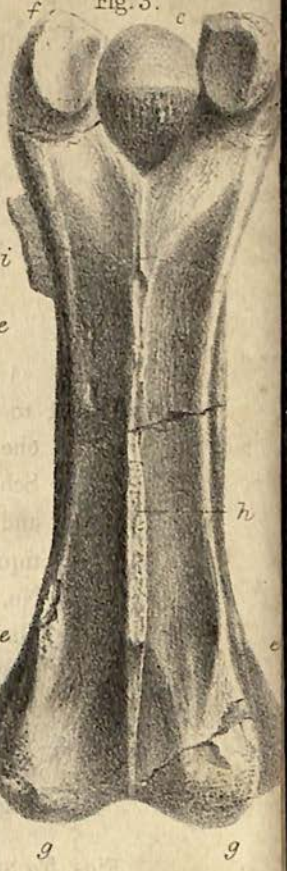


Fig. 2.

Fig. 5.

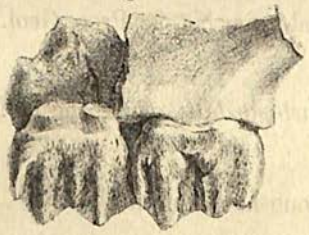


Fig. 5a

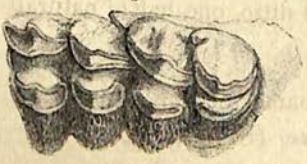


Fig. 10.

Fig. 7.

Fig. 6.

Fig. 8.

Fig. 9.

C. Scharf del. J. Dinkel lith.

W. West imp.

1 to 4. Camelopardalis Sivalensis. 5 to 10. C. affinis.

	Sewalik Fossil. Inches	Nubian Recent. Inches
Length between the ends of the oblique processes	8·1	7·5
Length of the body of the vertebra between the articulating heads	7·8	
Greatest width at the posterior end of the body, between the transverse processes	3·1	2·8
Least width at the middle of the body, between the upper transverse processes	1·65	1·6
Width between the outer margins of the upper oblique processes	2·65	2·55
Width of sinus between the upper oblique processes	1·1	1·2
Width between outer edges of posterior oblique processes	2·5	2·3
Least width of spinal arch between the ridges connecting the upper and lower oblique processes	1·25	1·0
Vertical diameter, posterior end of vertebra	3·6	3·8
Vertical diameter, anterior end, between the inferior border articulating head and upper margin spinal canal	2·6	2·7
Antero-posterior diameter articulating head	1·9	1·55
Transverse diameter articulating head at the middle	1·4	1·5
Greatest diameter articulating head	1·4	1·8
Vertical height articulating head	1·0	
Length of articulating surface, lower oblique process	1·6	1·2
Width of ditto	1·0	0·8
Length of articulating surface, upper oblique process	1·2	0·85
Width of ditto	0·8	0·7
Vertical diameter, spinal marrow, posterior end	1·25	
Vertical diameter, articulating cup, posterior end	2·0	2·2
Transverse diameter ditto ditto	2·0	2·3
Diameter upper transverse processes	0·8	0·7

Hence the authors conclude that there belonged to the Sewalik fauna a true well-marked species of giraffe closely resembling the existing species in form, but one-third less in height, and with a neck proportionately more slender; and for this small species they propose the name *Camelopardalis Sivalensis.*

Second Fossil Species of Giraffe.—The fossil specimens next to be described have been in the possession of the authors ever since 1836. They are fragments from the upper and lower jaws of another fossil species of giraffe, in which the teeth are so exactly of the same size and form with those of the existing species, and so perfectly resemble them in every respect, that it requires the calipers to establish any difference between them.

The largest specimen (Pl. XVI. figs. 5, 5 *a*) is a fragment of a left upper jaw containing the two rear molars. The back part of the maxilla, beyond the teeth, is attached, and clearly proves that they belonged to a full grown animal. These teeth were compared with the teeth, in the same stage of wearing, contained in the head of an adult female giraffe belonging to the Museum of the College of Surgeons, and the fossil and recent teeth were found to agree together in the most minute particulars. The following are the corresponding dimensions of the fossil and recent teeth :—

	Fossil. Inches	Recent. Inches
Joint length of the two back molars, upper jaw	2·5	2·55
Greatest width of last molar	1·4	1·3
Ditto ditto of penultimate molar	1·45	1·35

The second specimen (Pl. XVI. fig. 6) is the rear molar of the right upper jaw, corresponding exactly in size and form with that of the left side, but if anything, rather more worn, and belonging therefore probably to a different individual. The agreement extends down to the small cone of enamel at the base of the hollow between the barrels on the inside. Its dimensions are :—

Length	1·2 inch.
Width	1·4

The third specimen (Pl. XVI. fig. 7) is a fragment of the left lower jaw, containing the last molar. It has precisely the form and proportions of the corresponding tooth in the left lower jaw of the female head referred to, and the same development of its third barrel or heel, which is always found in this tooth in ruminants. Its dimensions are :—

Length	1·7 inch.
Greatest width	1·0

The fourth specimen (Pl. XVI. fig. 8) is the last false molar of the left lower jaw, detached. It agrees closely with the corresponding tooth in the recent female head above referred to. This tooth is thicker in proportion to its length in the giraffe than in other ruminants, and this constitutes one of the most distinctive characters of the giraffe's premolars. The anterior semi-barrel appears a trifle longer than the corresponding tooth of the recent animal; but this is owing to a difference of wear, and is not borne out by measurement. The dimensions are :—

	Fossil.	Recent.
Length	1·0 inch.	1·0 inch.
Breadth	0·9	0·86

The authors are possessed of the same tooth of the right lower jaw, detached; but have not thought it necessary to figure it.

The fifth specimen (Pl. XVI. fig. 9) is the penultimate false molar of the right upper jaw. It is of the same size and form with the corresponding tooth in the recent female head, with this difference, that it has three tubercles at the inside of the base. On a sixth specimen of the first false molar of the right upper jaw, which is not represented among the figures, there are three similar tubercles similarly placed.

It would require an extensive comparison of recent heads to determine what value attaches to this peculiarity; whether the tubercles are constantly absent from the teeth of the recent species, or appear occasionally as a variation on those of individuals. The dimensions of the penultimate false molar of the upper jaw are :—

	Fossil.	Recent.
Length	1·0 inch.	0·95 inch.
Breadth.	1·12	1·12

There is a peculiar, finely reticular, striated and rugose surface to the enamel of the teeth of certain quadrupeds, the appearance of which the authors compare to that of a fine net, forcibly extended, so as to bring the sides of the meshes together. This texture they formerly described as existing on the surface of the molars of the Sivatherium. It is found also on the teeth of the recent giraffe, and is more or less conspicuous on those of the hippopotamus. It is not observed in the camel, the moose deer, or the larger bovine ruminants; or if ever present, it is but faintly developed. This texture is well marked on the enamel of the teeth of this second species of giraffe. A magnified representation of it is given in Pl. XVI. fig. 10.

The series of teeth last described, excepting the fifth and sixth specimens, are all but undistinguishable from those of the Nubian giraffe; and the authors have sought in vain for any distinctive character by which to discriminate them. There is no good evidence to show that this fossil species and the living are even different; but in putting the case thus, the authors are far from advancing that the species are identical. The materials are far too scanty to warrant a conjecture to that extent.

Since the neck of the *C. Sivalensis* was one-third too short and slender to sustain the head that would have suited the teeth last described, the authors consider it a necessary consequence that these teeth belonged to a distinct species. Had the difference been less considerable, they might have hesitated regarding this conclusion; but the difference between 8 inches and 12 inches in the length of the same cervical vertebra of two adult animals of the same genus admits, in their opinion, of no other construction than distinctness of species. For the present, until sufficient materials shall be obtained to determine the relationship between the African giraffe and the second Sewalik species, in reference to their supposed resemblance, the authors propose to mark the latter by the provisional name of *Camelopardalis affinis*.

General Remarks.—In a former communication to the Society (Geol. Trans. 2nd ser. vol. v. p. 503) the authors noticed the remarkable mixture of extinct and recent forms which constituted the ancient fauna of Northern India. An extinct testudinate form, *Colossochelys Atlas*, as enormous in reference to other known Chelonians as the Saurians of the lias and the oolite are to their existing analogues, is there associated with one or more of the same species of crocodile that now inhabit the rivers of India. The evidence respecting one of these species of crocodile, resting as it does on numerous remains of individuals of all ages, is considered by the authors as nearly conclusive of the identity of the fossil with its recent analogue. These reptiles occur together with extinct species of such very modern types as the monkey, the camel, the antelope, and (as has now been shown) the giraffe; and these are met by species of the extinct genera Sivatherium and Anoplotherium. As regards the geographical distribution of the true Anoplotheria, those hitherto discovered have been confined, as the authors believe, to Europe; and as regards their geological distribution, to the older and middle tertiaries. In India this genus continued down to the period when existing Indian crocodiles and probably some other recent forms had become inhabitants of that region.

It might be expected that in a deposit containing Anoplotherium, Palæotherian remains also would sooner or later be discovered. However, among the very large collection of fossil bones from the tertiary sub-Himalayan range, made by the authors during ten years in that part of India, they have never found a single fragment of a head or tooth which they were able to refer to Palæotherium. This is merely a negative result, and only proves the rarity of that form.[1]

Although there occur among the Sewalik fossils abundant remains of almost every large pachydermatous genus, such as the elephant, mastodon, rhinoceros, hippopotamus, sus,

[1] Mr. M'Clelland, in his paper on *Hexaprotodon* (Journ. Asiatic Society of Bengal, vol. vii. p. 1046) casually mentions a species of Palæotherium as occurring among the Sewalik fossils. But he does not describe or figure the specimen. Messrs. Baker and Durand in their remarks appended to their catalogue of the Dadoopoor collection (*Idem*, vol. v. p. 836), mention four specimens containing teeth of the upper and lower jaws belonging to what they provisionally designate 'Cuvierian genera:' in regard to one of which, having the upper and lower jaws in contact, they state that, 'although it affords some analogies both to the Palæotherium and Anoplotherium, its essential peculiarities are sufficiently remarkable to cause it to be separated from either genus.' Till these specimens are either figured or described, the point must remain undecided in regard to Palæotherium being represented in the Sewalik fauna. [These specimens are described in the subsequent paper on '*Chalicotherium*.'—Ed.]

horse, &c., yet no remain has been found referrible to the Tapir, a fact the more remarkable, inasmuch as one of the only two existing species of that genus is now confined to the larger Indian islands and a part of the adjoining continent.

The finding of the giraffe as a fossil furnishes another link to the rapidly increasing chain which (as the discoveries of year after year evince) will sooner or later connect extinct with existing forms in a continuous series. The antelope and the bovine and antlered ruminants have numerous representatives, both recent and fossil. The camel tribe comprises a considerable fossil group, represented in India by the *Camelus Sivalensis*, and is closely approached in America by the extinct pachydermatous Macrauchenia. The giraffe has hitherto been confined, like the human race, to a single species, and has occupied an isolated position in the order to which it belongs. It is now as closely represented by its fossil analogues as the camel; and it may be expected that, when the ossiferous beds of Asia and Africa are better known, other intermediate forms will be found, filling up the wide interval which now separates the giraffe from the antlered ruminants, its nearest allies in the order according to Cuvier and Owen.[1]

The giraffe throws a new light on the original physical characters of Northern India; for whatever may be urged in regard to the possible range of its vegetable food, it is very clear that, like the existing species, it must have inhabited an open country, and had broad plains to roam over. In a densely forest-clad tract, like that which now skirts the foot of the Himalayahs, it would soon have been exterminated by the large feline feræ, by the hyænas, and large predaceous bears which are known to have been members of the old Sewalik fauna.

Postscript.—Since the above remarks were submitted to the Society, M. Duvernoy's paper, embodying two communications read to the Academy of Sciences on the 19th May and 27th November last, has appeared in the January number of the 'Annales des Sciences Naturelles.' These notices were published in the 'Comptes Rendus,' but were unknown to the authors at the time. M. Duvernoy describes the lower jaw of a fossil giraffe found in the bottom of a well, lying on the surface of a yellow clay, along with fragments of pottery

[1] M. G. de St. Hilaire, in his zeal for the mutability of species, imagined that he had detected in the Sivatherium the primeval type which time and necessity had fined down into the giraffe. Anatomical proofs were all against this inference; but if a shadow of doubt remained, it must yield to the fact, that in the Sewalik fauna the Giraffe and the Sivatherium were contemporaries.

and domestic utensils, in the court of an ancient donjon of the 14th century in the town of Isoodun, Département de l'Indre. Considerable doubt remains as to the bed and source whence the fossil was derived. M. Duvernoy attributes the jaw to a distinct species of giraffe, which he names *Camelopardalis Biturigum*. Professor Owen, from the examination of a cast, confirms the result, expressing his conviction 'that in the more essential characters the Isoodun fossil closely approaches the genus Giraffe, but differs strikingly from the (*single*) existing species of the south and east of Africa, and that the deviations tend towards the sub-genus Elk.'

M. Duvernoy also mentions the discovery by M. Nicolet of a tooth in the molasse near Neufchatel, determined by M. Agassiz to be the outer incisor of a fossil giraffe.—*Duvernoy, Annales des Sciences Naturelles*, No. for January 1844.

APPENDIX.

I.—Description by Dr. Falconer of Fossil Remains of Giraffe in the Museum of Asiatic Society of Bengal.

A. From the Sewalik Hills.

No. 405. *Camelopardalis Sivalensis.*—Upper extremity of right metacarpus, probably of *Giraffe*, so inferred from sudden contraction below articular head. From the Sewalik hills near Nahun.

No. 560. *Camelopardalis Sivalensis*?—Fine fragment comprising the lower jaw, right side, with three milk molars *in situ*, and the germ of the first true molar embedded in the jaw. The teeth are well preserved, the two posterior premolars being only slightly touched by wear, the third milk molar shows the three barrels and composite form characteristic of that tooth; the surface of the enamel presents in a well-marked manner the peculiar netted rugosity, which distinguishes the teeth of the *Sivatherium* and *Brahmatherium* and *Giraffe*. The jaw evidently belonged to a young animal. The body of the horizontal ramus is thick, a portion of the diasteme remains, which is thick and low; there are no materials of comparison to determine with certainty to what genus the fossil belongs; but it is inferred from the characters of the enamel and general form to be the lower jaw of a young *Giraffe*.

No. 561. *Camelopardalis Sivalensis.*—Fragment of lower jaw, left side, horizontal ramus, with three milk molars of a still younger animal than No. 560, and of smaller proportions, containing the three milk molars of which the most anterior is in germ, and just protruding from the jaw; the germ of the first true molar is seen behind. Enamel surface of this specimen also shows rugous netting; but it is too imperfect for confident determination.

No. 690. *Camelopardalis Sivalensis.*—Fragment comprising the

upper portion of the shaft of the left radius, the articulating head broken off; the bone is much flattened, and its outer border forms a considerable curve, in consequence of the abrupt expansion of the articulating head, and the sudden contraction of the shaft below it. It is not apparent whether the articulating epiphyses had been synostosed; but the bone is nearly equal in all its principal dimensions to the corresponding one of the existing *Giraffe*, though it is considerably more flattened. It has the greyish weathered appearance of a Sewalik fossil of the sandstone matrix. This is a valuable and rare specimen. Presented by Col. Colvin.

B. From Perim Island.

No. 43. *Camelopardalis Sivalensis* ?—Humerus, right, in two fragments; lower articulating surface perfect; the upper broken off immediately below the head; resembling in form exactly the humerus of the giraffe, but a little larger.

No. 52. *Camelopardalis.*—Lower end of metacarpal bone, left side, with articulating surfaces, of the size of existing giraffe.

No. 60. *Camelopardalis.*—Second or third dorsal vertebra of giraffe, concave and convex articular surfaces present, apophyses wanting.

II.—On the Number of Existing Species of Giraffe.

MS. Memorandum from Note-Book.

Some naturalists have attempted to establish two species of giraffe, founded chiefly on the geographical range of the Nubian and South African varieties, and on external characters derived from the skin. But any conclusions built on the former would be begging the question, and dermal marks are insufficient to sustain a case of the kind, unless borne out by peculiarities in the skeleton, or other structural differences. Those who have seen the range of colour through which the tropical antelopes run, from a light blue or pale ash in the young male through every grade to a deep black in the old, such as is presented in the *Antilope cervicapra* and *Damalis risia*, will distrust any distinction resting on the skin marks or development of the knee scopæ in the giraffe. The distinctness of the suture of the bone which supports the alleged third or intra-orbital horn, and the great relief of the pedicle shown in the figures in Rüppel's atlas have been adduced as proofs of the specific difference of the North African giraffe; but Professor Owen states that he could detect no evidence of such a suture on the original cranium. I am informed, also, by a distinguished zoologist, and one of our best authorities on the *Ruminantia* that he examined the head from which the figures were taken, in the Frankfort Museum, along with Dr. Rüppel, and found *neither the suture nor the elevated pedicle shown in the figures*, both of which Dr. Rüppel admitted to be exaggerations introduced by the artist who drew them. No good evidence, therefore, has been adduced in favour of there being two existing species of Giraffe; the proofs at present all tend to the opposite conclusion. My authority, however, found a considerable difference in the extent and figure of the lachrymal bone, a character, if constant, of much importance.—[H. F.]

X. ON CHALICOTHERIUM SIVALENSE.[1]

BY H. FALCONER, M.D.

On November 15, 1843, a paper by Major Cautley and myself was read to the Geological Society, entitled 'On some Fossil Remains of Anoplotherium and Giraffe from the Sewalik Hills,' &c., an abstract of which appeared in No. 98 of the Society's 'Proceedings.' In the concluding remarks upon the species referred to *Anoplotherium*, we stated that our fossils came nearest to the *Chalicotherium* of Kaup, and that the generic determination then assigned to them by us was to be considered more as provisional than positive, pending the discovery of other more conclusive materials. This opinion is expressed in the 'Abstract' in the following terms:—

'On the whole the Sewalik species appears to be most closely allied to the *Chalicotherium Goldfussi*. The existence of a vacant diasteme in front of the anterior tooth would constitute a difference from the Anoplotherian type of some importance. The characters generally show a return from the ruminant tendencies of the Cuvierian species back to a more pachydermatous type and a closer affinity with Rhinoceros, between which and *Anoplotherium commune* it may ultimately prove to be an intermediate form. Until the evidence for separation is conclusive, the authors suggest leaving it with the genus *Anoplotherium*.' ('Proceedings,' No. 98, p. 239; and *antea*, p. 195.)

Our reasons for hesitating to adopt Kaup's generic name of *Chalicotherium* arose from our entertaining doubts regarding the validity of the grounds urged by that eminent palæontologist,[2] for establishing the genus as distinct from *Anoplotherium*. The characters adduced by Kaup were, the ascertained form of the back molars of the upper jaw, but more especially the supposed form of the incisors and canines. We suggested that the complicated crown

[1] This paper was written in October 1847, for the Geological Society, but was never presented, and is now for the first time published. For the measurements of the specimens described in the paper the reader is referred to the description of Plate lxxx. of the Fauna Ant. Siv.—[Ed.]

[2] Oss. Foss. de Darmstadt, livrais. ii. p. 30, Pl. vii.

and the compound fang of the tooth regarded by him as an incisor proved it rather to be one of the anterior premolars, an inference which has proved to have been correct; and that the supposed upper canine resembled more the incisor of a species of Rhinoceros, to which it would appear Dr. Kaup now refers it. The only other adduced character was the form of the back molars, which, admitting the amount of difference indicated, did not appear to us to be of sufficient importance to constitute, alone, the basis of a generic distinction, as these molars upon the whole exhibited little more than 'an enlarged and less rectangular representation of those of *Anoplotherium*,' with which they entirely agreed in the insulation of the conical cusp, so characteristic of that genus.

Since the date of the memoir in question additional materials have turned up to us, which fully establish the validity of Kaup's genus; while they prove at the same time the Sewalik species of *Chalicotherium*, through a very unexpected combination of characters in the construction of the jaws, to have been widely different from *Anoplotherium*. So unexpected, indeed, are those characters that *Chalicotherium* must be regarded as one of the most remarkable and aberrant pachyderms that has yet been met with, either in the fossil or recent state.

The object of the present communication is to make known the nature of the new evidence respecting the Indian fossil species, and to extend its comparison with the European species, upon the additional specimens discovered at Eppelsheim, which have been figured and described by Kaup in the 'Akten der Urwelt.' It would appear, by a manuscript communication from Mons. Pomel, that remains of the same genus, and probably of the Eppelsheim species, have been discovered in the rich ossiferous beds near Sansans, in the south of France, associated with *Dinotherium*, *Mastodon*, and other forms characteristic of the miocene deposits of Eppelsheim.

The specimens now at our disposal put us in possession of the whole of the dental characters of *Chalicotherium Sivalense*. The most important is a fragment comprising the anterior half of an adult head, with the upper and lower jaws in natural apposition, and exhibiting the greatest portion of the dental series of both jaws (Plate XVII. figs. 3 and 4). The two back molars, deficient in this specimen, are fortunately shown in the most perfect state of preservation by the fragments represented in our previous memoir (Plate XVII. figs. 1 and 2). This beautiful specimen, originally in the Dadoopoor collection of Major Baker and Captain Durand, of the Bengal

Engineers, belongs now to the Museum of Marischal College, Aberdeen, the authorities of which University with the most prompt liberality forwarded it to London for comparison and description, on the application of Major Cautley and myself to that effect. It was found embedded in a yellow clay matrix, being in the mineral condition, which we have elsewhere designated as 'soft fossil.' (Geological Proceedings, *loc. cit.* p. 235.) The head when discovered *in situ* appears to have been in the most complete state of integrity, judging from the undisturbed condition of the parts now remaining, and to have been broken during the process of excavation by the native collectors employed for the purpose. In consequence of this unlucky accident, we are for the present deprived of the important information which the specimen would otherwise have yielded, regarding the construction and relations of the cranium proper of *Chalicotherium*.

The specimen next in importance is a fragment comprising the left half of the lower jaw, from the angle on to the commencement of the symphysis, of an individual which was not quite full grown. It supplies the character of nearly the whole of the inferior molar series. It is in the mineral condition which we have called 'hard fossil' (Proceedings, *loc. cit.*), having been embedded in a sandstone matrix. This specimen was forwarded during last May to Paris for examination and comparison by M. Laurillard, in the hope that it might be matched by some remains in the French palæontological collections; and I am indebted to that excellent observer, and to M. Pomel, through the kindness of Sir Roderick Murchison, for opinions respecting it which I shall have occasion to refer to in the sequel (Plate XVII. figs. 6 and 7).

The detailed description of the teeth given in our first memoir was published in an abbreviated form in the 'Proceedings,' the abstract not having been the production of the authors. Although correct in the main points, the descriptive minutiæ —a matter of prime importance where teeth are concerned— were so abridged in the abstract, that I deem it necessary on the present occasion to claim the indulgence of the Society for redescribing the teeth, more especially with reference to the new light which the specimens since acquired have reflected on the dental characters of *Chalicotherium*.

Incisors.—First with regard to the incisors. THERE WERE NO INCISIVE TEETH to *Chalicotherium Sivalense* in either jaw! It was as toothless in this respect as the most typical among the *Edentata*. The evidence is happily of the most demonstrative character. The intermaxillary bones are preserved in the upper jaw of the Dadoopoor specimen (fig. 3), perfect to their tips. They consist of narrow slender slips of bone

DESCRIPTION OF PLATE XVII.

CHALICOTHERIUM SIVALENSE.

Fig. 1. Left upper jaw containing three molars and three premolars of *Chalicotherium Sivalense*, one-half of the natural size. Copied from a drawing by Mr. Ford in the Fauna Antiqua Sivalensis, Plate LXXX., fig. 3. *a*, *a'*, *a''*, the conical cusps. This specimen, which is in the British Museum, was also figured in the Proc. Geol. Soc., No. 98, as *Anoplotherium Sivalense*. (See pages 191, 216 & 524.)

Fig. 2. Upper jaw, right side, with the four back molars, and part of the orbit of *Chalicotherium Sivalense*, one-half of the natural size. Copied from fig. 2 of Plate LXXX. of F. A. S., and fig. 2, Plate II., of Proc. Geol. Soc., No. 98. Specimen in British Museum. (See pages 194, 213 & 523.)

Figs. 3 and 4. Anterior half of an adult head of *Chalicotherium Sivalense*, one-half of the natural size. Copied from drawings by Mr. Ford in Plate LXXX. of the F. A. S. The upper and lower jaws are in natural apposition, and the greater portion of the dental series of both jaws is visible. The specimen is in the Museum of Marischal College, Aberdeen. (See pages 209 & 523.)

Fig. 5. Is anterior portion of lower jaw of same specimen as last, showing the two canines. (See page 211.)

Figs. 6 and 7. Left half of lower jaw of *Chalicotherium Sivalense*, one-half of the natural size. Copied from drawings by Mr. Ford in Plate LXXX. of the F. A. S. Specimen in British Museum. (See pages 210 & 524.)

Fig. 3.

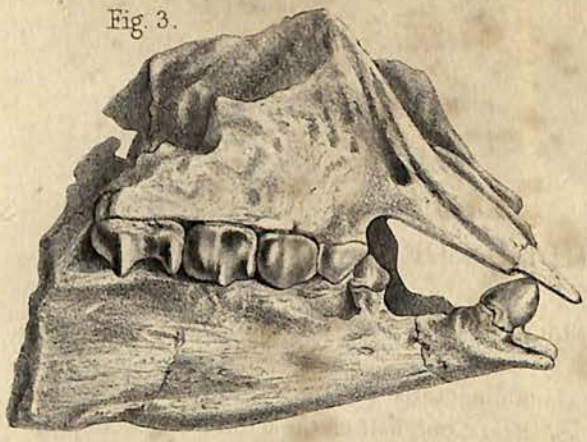


Fig. 4.

Fig. 2.

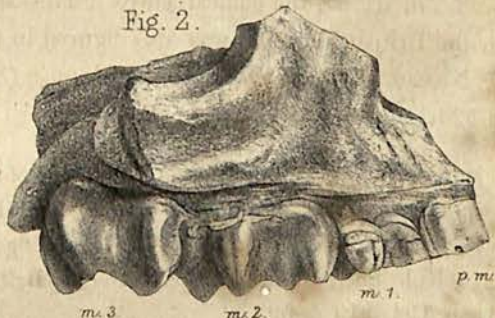


Fig. 5.

Fig. 1.

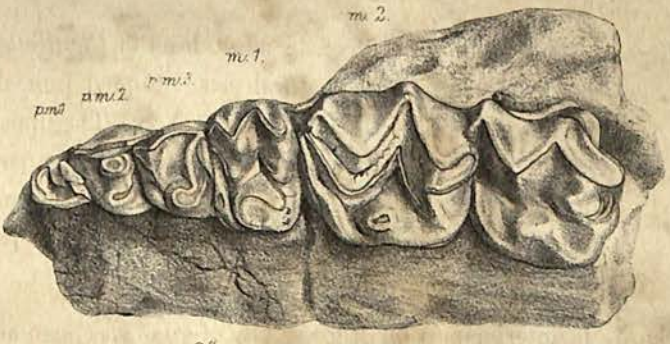
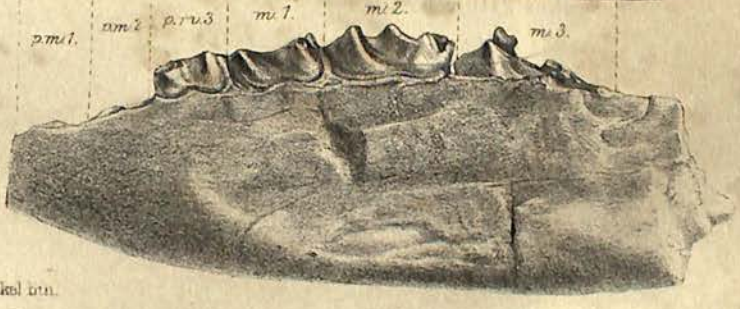


Fig. 6.

Fig. 7.



G.H.Ford del. J.Dinkel lith.

W.West imp.

Chalicotherium Sivalense.

converging to a sharp point, in which it is apparent not only that there were no incisors, but also that such teeth could not at any period of the animal's age have existed in a developed form in the upper jaw. These intermaxillary bones are even more rudimentary in amount of development than occurs in the typical Ruminantia, with which order they closely agree in form. The evidence respecting the absence of lower incisors is equally conclusive. The anterior portion of the lower jaw of the same specimen is perfect to the alveolar edge. A detached canine is seen on either side, but the intervening space, ordinarily occupied by incisors, is without a vestige of such teeth; and the alveolar border of the incisive region is contracted in correspondence with the convergence of the intermaxillary bones above, and sloped off to a fine edge, in which it is clear that no incisive teeth could have been implanted. There is not a trace of them, even in the most rudimentary form.

We have here then, in the absence of incisive teeth in both jaws, a character of a very unexpected nature, which at once distinguishes *Chalicotherium* from *Anoplotherium*, and from every other known genus of the order. There is nothing analogous to it among any of the *Ungulata*, whether pachyderms or ruminants, hitherto described.

Canines.—The upper jaw of *Chalicotherium Sivalense* was equally devoid of canines as of incisors. A vacant diasteme of considerable length stretches without interruption from the anterior premolar to the tip of the intermaxillary bone, on either side. The animal was of sufficient age to have developed permanent canines, if the species had been supplied with such teeth; and there is no indication upon the diasteme in the shape of an obliterated alveolar pit, that the fossil was furnished with deciduous canines of the milk series in the upper jaw. A slight vacuity has been picked out, in clearing away the matrix, on the diasteme at the point of junction between the maxillary and intermaxillary bones, which at first sight might be taken for the alveolus of a very rudimentary canine; but the appearance, partly caused by an accidental fracture, is deceptive; the vacancy is seen to extend across the palate, and indicates merely the very slight nature of the connection between the maxillary and intermaxillary bones. In this second character of dental suppression the Sewalik *Chalicotherium* also differs from *Anoplotherium*.

But canines were present in the lower jaw. They are represented by figs. 3 and 5. The crown is thick, cuneiform, and somewhat triangular in shape, thinning off into a blunt apex, the anterior edge being short and nearly vertical, while the posterior edge is longer and more sloping. It is implanted with

an inclination forward, by a strong thick simple fang, equalling the crown in diameter. It is nearly of the same size and form as the anterior premolar, and does not rise above the level of that tooth. The enamel of the apex is polished by attrition against the pad of the upper gum, but unworn. In the mode of implantation, general incisor-like form, and degree of development, the lower canine of *Chalicotherium* agrees with the corresponding tooth of *Anoplotherium commune*; but the crown is more simple, being devoid of the basal-notched lobules occurring in the latter genus. Its position in the jaw is also more advanced than in *Anoplotherium*; the diastemal interval of nearly an inch exceeding the space which would have been occupied by the first or suppressed premolar, had the latter tooth been developed.

Was there any sexual difference in the canines of *Chalicotherium*? Were they present in the male and wanting to the female? Was the fossil from a male or female? These are interesting points to determine; but with materials at present limited to a single example it would be idle to attempt solving them; for irregularities in the degree and order of dental suppression are so numerous and variable among different genera in the Ungulate tribes, that there is not a clue to a probable inference on the subject. That the canines in the fossil were full grown is proved by the form of the crown and condition of the fang, independently of the evidence furnished by the wear attained by the penultimate molar that the animal was adult.

Further, it may be urged that the teeth here described as canines may be considered rather as representing the outermost incisor of either side. This is in some measure an open question, but the massive deeply-implanted fang is entirely that of a canine; and the teeth have the position ordinarily occupied by the canines in allied genera. The analogy of the upper jaw, so far as it is worth, is also against their being regarded as incisors.

Kaup, in his first account of *Chalicotherium*, describes and figures a large tooth, which was found detached, as probably a canine of *C. Goldfussi*; but it is omitted among the figures given with his more recent description in the 'Akten der Urwelt;' whence it would appear that he no longer holds that opinion. In our first memoir it was regarded as a lower incisor of one of the Eppelsheim species of rhinoceros. The evidence now adduced regarding the Sewalik fossil proves, *a fortiori*, that it could not have been a canine of a species of *Chalicotherium*. Bronn describes it, in accordance with Kaup's first opinion, and thereon rests a conclusion as to the affinities of the genus.

Molars.—Next, with regard to the molar teeth. There were six molars on either side in both jaws of *Chalicotherium Sivalense*. For those of the upper jaw I must revert to the figures previously given in the 'Proceedings' (Pl. XVII. figs. 1 and 2). The jaws being locked in the Dadoopoor specimen, the crown surfaces of the teeth are not visible for description. Fig. 1 represents the left side of the upper jaw, with the whole of the molar series *in situ* beautifully preserved, of an adult animal. In the 'Akten der Urwelt,' Kaup has figured a corresponding fragment of the left upper jaw of *Chalicotherium Goldfussi* from Eppelsheim, containing also a series of six molars. The teeth of the two species are exceedingly alike in form and proportions, those of the European species being larger; they both exhibit a strong resemblance to the molars of *Anoplotherium commune*, as represented by Cuvier in Pl. XLVI. fig. 2, vol. iii. of the 'Ossemens Fossiles.' The Sewalik specimen and the latter correspond exactly in age, the last molar in both being in the germ state, with the ridges scarcely affected by wear. The comparison between them is in consequence greatly facilitated. The teeth in the Eppelsheim specimen are more worn.

Upper Molars.—The crowns of the true molars (2 m. 3 m.) in *Chalicotherium Sivalense* form irregular cubes, with a square deeply excavated grinding surface broken up into four principal points or 'hillocks,' separated longitudinally and transversely by wide open clefts. The outer surface, as in *Palæotherium* and *Anoplotherium*, is divided unequally into two hollow interspaces by three vertical eminences, ascending from the base about half-way upwards; but the anterior and central of these elevations, instead of being well defined and keel-shaped, as in the two latter genera, form in *Chalicotherium* enormous rounded convex bulges, projecting much above the level of the hollow spaces included between them, while the posterior angle is depressed and overlapped by the anterior bulge of the next succeeding tooth. In *Rhinoceros* these eminences are obsolete, the outer surface of the upper grinders being nearly flat; in *Anoplotherium* they are well marked, as also in *Palæotherium*; in *Chalicotherium* they attain the maximum of development presented by the Ungulate genera, fossil or recent. In *Ch. Goldfussi* of Kaup the anterior of these bulges is the largest, and it is notched at the apex, so as to resemble very closely the corresponding lobe or anterior semicone of the upper grinder of *Lophiodon Tapiroïdes*. They further agree in the horizontal outline, and in the low elevation of the crown. But here the resemblance ceases; the form and position of the other principal points and the transverse direction of the main ridges ar

entirely different in *Lophiodon*. In the Sewalik species the middle bulge is the most salient, and most deeply notched at the apex, where it forms an obtuse lobule. The two hollow interspaces are strongly inclined inwards as they ascend and terminate each in a three-sided pyramidal point, forming in the vertical direction a double chevron or W outline, the re-entering angles being at the apices of the bulges. In like manner, from the inflexion of the pointed terminations of the hollows and the projection of the bulges, the outer longitudinal ridge of the crown follows a bold zig-zag direction, and another double chevron is formed in the horizontal plane of the grinding surface. All this takes place in *Chalicotherium*, exactly as in *Palæotherium* and *Anoplotherium*, but in a greater degree, the angular flexures being more marked. The anterior hollow space is considerably wider than the posterior, which especially in the last molar slopes inwards towards the back end of the tooth. *Ch. Goldfussi*, in these particulars, agrees entirely with the Sewalik species, but besides the lesser elevation of the crown the angular flexures of the outer longitudinal ridge are still greater, so that their apices occupy nearly the middle of the grinding surface.

The anterior outer principal point, which forms in the germ a distinct three-sided pyramid, wears down into a crescentic disc of ivory. Its inner edge descends nearly vertically towards the great central hollow, and is not connected by means of a uniting ridge with the internal large conical point which is opposed to it. A wide angular gap intervenes between them.

The posterior outer lobe forms a similar, but smaller, three-sided low pyramid, the inner angle of which is connected with a corresponding ridge from the posterior inner 'hillock' opposed to it. A wide fissure having an antero-posterior direction, and opening towards the posterior side of the crown, intervenes. It is not as in *Anoplotherium* continuous with the central longitudinal valley, but terminates at the angle of junction of the posterior lobes, as in *Palæotherium* and *Rhinoceros*, giving rise in advanced wear to an isolated patch of enamel corresponding with the posterior annular 'fossette,' described by Cuvier in these genera. This fossette is well shown by the third molar, which is much worn.

The inner side of the crown is rounded at the angles, and forms a nearly semicircular contour towards the palate. Like the outer division, it is composed of two principal lobes or 'hillocks.' The posterior of these forms a low three-sided pyramid smaller than the corresponding outer lobe which is opposed to it. It is separated from the great conical tubercle which constitutes the anterior eminence by a wide gap formed

by the opening of the bisecting transverse valley, which expands in the centre of the tooth into a deep and very open irregular fissure having a triangular bottom.

The conical tubercle is situated at the inner side, as in *Anoplotherium*, and forms a large projecting lobe arising from a broad disconnected circular base. The side towards the palate is nearly vertical; the apex is compressed into a sharp convex edge, sloping off towards the centre of the tooth. It stands opposed to the anterior outer pyramid, an angular gap intervening. A low ridge forming the inner margin of the crown descends from its base, connecting it with the posterior inner pyramid and subtending the opening of the transverse bisecting valley. A similar ridge from the anterior side of the base connects it with a small front lobe to be next noticed. These connecting ridges are wanting in *Anoplotherium*; they continue intact during advanced wear, as arcuate enamel cornua appended to the disc of the tubercle. In consequence of its isolated position, the conical tubercle remains long unconfounded with the confluent discs of the other lobes; the apex is first abraded obliquely on the side next the axis of the tooth; it then wears down to a depressed disc of ivory encircled by a ring of enamel, and it remains in this state when the other coronal eminences are ground down to a common field; while in *Anoplotherium* it is lost at a much earlier period.

Up to this point the accordance of *Chalicotherium Sivalense* with *Anoplotherium commune* is complete, in the general representation of the coronal lobes of the back molars. But in *Anoplotherium*, corresponding with the anterior outer hillock there is an interior smaller lobe in front of it, separated by a distinct furrow, the two forming, like the posterior lobes, an opposed anterior pair. This lobe, which represents the anterior inner crescent of the symmetrical molars of the ruminants, is less developed in *Anoplotherium* than the other lobes, and during wear it does not present more than an oblong disc, corresponding with the anterior horn of the ordinary crescent. This reduction in form is accompanied by an excessive development of the fifth coronal eminence, or 'conical tubercle,' which in the allied genera ordinarily forms only a slender pillar at the opening of the transverse middle valley. The deviation from the typical symmetry of the ruminants first visible in *Anoplotherium* is carried out still further in *Chalicotherium*, the anterior inner lobe being still more reduced, while the conical tubercle is proportionally still more developed. The exact determination of this point in the fossil is of great interest, as the symmetry or otherwise of this part of the molars usually bears an important relation

to the construction of the extremities as regards the number of toes, thereby indicating the affinities of the genus.

The characters presented by the reduced inner lobe in *Chalicotherium Sivalense* are these:—From the apex of the anterior outer vertical bulge a low ridge proceeds across, bounding the tooth in front; it is concealed about the middle of its course by the overlapping of the adjoining tooth, but reappears near the inner third of the distance, in the form of a low compressed tubercle, which, as above described, is continued forwards in an enamel ridge, sweeping round the base of the great conical lobe upon which it terminates. This small tubercle represents the inner division of the anterior pair in *Anoplotherium*. A well-marked anterior transverse narrow valley, which remains distinct after advanced wear, separates it from the corresponding and opposed outer lobe, and also from the base of the conical tubercle; therefore, the anterior inner, or fourth symmetrical lobe, which in *Anoplotherium* is reduced to one horn of the ordinary crescent, is still more rudimentary in *Chalicotherium*, attaining little beyond the development of an anterior 'talon,' while the conical tubercle, representing the fifth or odd coronal lobe, is proportionally enlarged at the expense of the reduced segment. There is no basal collar or 'bourrelet' upon this or any other part of the back molars of *Chalicotherium Sivalense*.

The difference of pattern yielded by the grinding in face during progressive wear is finely exhibited by the different conditions of the three back molars (Plate XVII. fig. 1). The last (m. 3) shows the germ form of the crown, the wear being limited to the posterior inner face of the anterior outer pyramid. The penultimate (m. 2) shows the two outer and the posterior inner lobe, half worn and confluent into a common field of ivory, while the conical tubercle is almost intact. The posterior fissure forms an open gap separated from the central valley by a belt of ivory, as in the molars of *Palæotherium*. The termination of the great transverse valley forms a triangular depression in the middle of the tooth, while its opening remains in the state presented by the germ. The anterior valley still presents the condition of a transverse fissure. The first true molar is considerably more advanced in wear; the united disc of the three pyramids is nearly flat; the posterior fissure is reduced to an oblong peninsular patch of 'fossette' of enamel; the conical tubercle is ground down to an isolated annular depression, with a divergent enamel ridge at either side; the transverse middle valley forms two triangular depressions united by a narrow neck; and the anterior transverse valley is reduced to two enamel pits, the

one corresponding in size and position with the posterior 'fossette' and the other separating the conical tubercle from the rudiment of the anterior inner lobe.

The upper back molars, more especially the two last, are enormously large, in comparison with the other teeth or with the dimensions of the head. If found isolated they would seem suitable to an animal approaching the size of a *Rhinoceros*, whereas the anterior part of the lower jaw and the muzzle do not reach the dimensions of the Indian Tapir.

Upper Premolars.—The upper premolars in *Chalicotherium* are limited to the three last: the normal first being suppressed. They differ more from the corresponding teeth of *Anoplotherium commune* than do the true molars. In the latter the premolars are compressed lengthwise, and their outer surface retains the three-ridged division which is presented by the true molars, while the conical tubercle, at the inner side, is lost in a salient edge, which goes all round the circuit of their oblong crown.[1] In *Chalicotherium Sivalense*, on the contrary, the premolars are compressed in the *transverse* direction, so as to make them somewhat cuneiform from the outside inwards; their outer surface loses the vertical bulges of the back molars and becomes nearly flat, as in Rhinoceros; while they retain the conical tubercle at the inside, as a well-marked distinct lobe throughout. Taken in succession, from rear to front, they diminish very rapidly in size, the united length of the three teeth not exceeding much the width of the penultimate true molar; while in *Anoplotherium commune* the proportion in length of the three true molars to the three last premolars is nearly as 3 to 2. The internal conical tubercle, as in the case of the back molars, gives off in front and behind a low basal ridge, bounding the teeth on their inner side. The form of the outer surface of these teeth is well shown on the right side of the Dadoopoor specimen. The antepenultimate or first (theoretically the second) has a cuneiform outline to the outer edge of the crown, and is implanted by a double connate fang. The second (p.m. 2) is of the same form but broader. The last (p.m. 3) is still broader, and presents an obscure indication vertically of a division into an anterior and posterior lobe. The first true molar (m. 1) which follows, is distinguished at once from the premolars by the saliency of its projecting bulges. The form presented by the worn grinding surface of the premolars is well exhibited by fig. 1

[1] 'Leur caractère est d'avoir dans le genre une couronne oblongue, entourée de toute parte d'un rebord saillant et tranchant.'—Cuvier, Oss. Foss., tom. iii, p. 19 (4to. edit.).

of Plate XVII. The inner conicle tubercle is retained on to the anterior tooth, with but an inconsiderable modification of the character which it shows in the back molar, and separated by an intervening valley from the outer lobe. There is no trace of a rudimentary first molar in any of the fragments. In the Dadoopoor specimen the alveolar border falls off in an abrupt step upon the diasteme in front of the anteror tooth.

The molars and premolars of the upper jaw of *C. Goldfussi* agree in form and proportions so nearly with those of *C. Sivalense* that it is not necessary to do more than refer to Kaup's figures. The crown ridges and principal points are less elevated, and the dividing vallies more open and shallower. The tooth which Kaup figures and describes as the middle lower incisor of the left side is here regarded as the penultimate upper premolar of the right side.

Inferior Molars.—The molars in the lower jaw, like those above, were limited to six, viz. three true molars and three premolars.

The Dadoopoor specimen, Plate XVII. figs. 3 and 4, shows on the left side the anterior four of these teeth entire, and the front half of the fifth, in apposition with the upper jaw, while the detached left ramus (figs. 6 and 7) presents the last four molars *in situ*, together with the empty alveoli of the two first. This fragment had belonged to a young animal which had just acquired its permanent teeth, the last premolar being fully protruded but unworn, while the last true molar is in the germ state, and had not entirely pushed through the gum; the crown of its posterior half is broken off. The teeth and the form of the jaw are so much alike in the two specimens, that there cannot be a doubt of their having belonged to the same species of animal.

The inferior molars of *Chalicotherium Sivalense* differ more from those of *Anoplotherium commune* than the upper, and the points in which they differ constitute characters of resemblance to *Palæotherium*, while at the same time they are marked by some peculiarities which are not met with in either of those genera. These teeth have the general form of those of *Palæotherium*, consisting of two semi-cylindrical lobes; and they further agree with the latter genus, in the two last premolars being double-barrelled, like the three true molars; while in *Anoplotherium* the premolars differ very materially in form from the back teeth. The convexity of the lobes is less uniform and cylindrical than in *Palæotherium*; as in *Anoplotherium* they contract upwards to a small pyramidal point at the outer side, but without bulging into convexities below, as in the latter genus; while at the same time they hardly ex-

hibit a vestige of the basal 'bourrelet,' or collar, which is so constantly found upon the teeth of *Palæotherium*. The trenchant edge of each lobe, after forming the small outer point, is bent round to the inner side, so as to form a compressed curve, which wears down to a crescentic pattern. There are two peculiarities connected with these edges which require special notice. The anterior edge of the front lobe descends uniformly and obliquely forwards, from the outer point to a low termination at the inner side, whence it shelves a short way backwards to join on with the base of the internal middle eminence, as occurs in the lower molars of *Macrauchenia Patagonica*, while its posterior edge and both edges of the rear lobe bend in a concave line across, to terminate each in a small elevated point at the inside; so that the posterior lobe has two inner points, while the anterior lobe has only one. This is precisely the reverse of what takes place in *Anoplotherium*, in which the anterior lobe has two internal points, while the rear lobe has only one. Further, the angle of junction of the two crescents forms a double or bifid point, as in the *Palæotherium* of Montpellier (*P. Aurelianense*) whereas in the other *Palæotheria* and in *Anoplotherium* it is always simple. This character was specially noticed by M. Laurillard, in comparing the fragment with lower jaws of *Palæotherium*, in the Paris Museum.[1] This bifid point is seen in Plate XVII. figs. 6 and 7; it is also exhibited by the first and second true molars of the Dadoopoor lower jaw, a vertical furrow indicating the line of division. The penultimate molar (m. 2) shows a well-marked posterior talon ridge, which commencing at the base of the posterior inner point is directed downwards and across to terminate at the base of the outer surface of the posterior crescent: thus reversing what is presented by the anterior edge of the front lobe. This talon is feebly developed on the first true molar (m. 1), and is entirely wanting to the last premolar (p.m. 3), being the only character by which the latter is distinguished from the true molars. Direct evidence as to the form of this talon in the last molar (m. 3) is wanting, in consequence of the fracture in the specimen of the posterior lobe; but enough of the outline remains to show that this tooth was devoid of the third lobe or crescent, which is constantly found in all the species of *Anoplotherium* and *Palæotherium*. This is a character of generic importance in which *Chalicotherium Sivalense* agrees

[1] 'Cette mâchoire semble tenir des Palæotheriums, des Anoplotheriums et des Rhinoceros. Les dents ont la forme générale de celles des Palæotheriums et surtout de celles du Palæoth. de Montpellier, puisque, l'angle de réunion des deux croissans est double, ou forme deux points en regardant les dents par la face interne,' &c.—(MSS. Com. from M. Laurillard.)

with *Macrauchenia Patagonica*, according to the lower jaw so determined by Owen,[1] and with Rhinoceros; but both of these genera are without the posterior 'talon' to the lower back molars, found in the Sewalik form. *Chalicotherium* differs also from Rhinoceros in the equal height of the anterior and posterior lobes.

The inferior molars decrease very uniformly in size from the last true molar to the penultimate or first (theoretically the second) premolar, which has a simple cuneiform crown resembling in size and shape the lower canine. It is implanted by a double confluent fang. The second premolar (theoretically the third) exhibits a reduced condition of the double crescent of the back molars, the internal point of junction being bifid and elevated as in them. The last premolar (p.m. 3) is double-barrelled and differs in no respect from the true molars except in the absence of the posterior talon. A question may be raised, whether the first premolar is not represented by the tooth above described as an inferior canine. But its advanced position in the jaw, close to the incisive border and the thick procumbent simple fang by which it is implanted, appear to be conclusive against a view of this kind.

In consequence of the close resemblance between the upper molars of the Sewalik and Eppelsheim species of *Chalicotherium*, it might be expected that the lower molars would also agree. Kaup describes and figures two teeth which he refers to the lower jaw of *Chalicotherium*. I have compared casts of these with the lower molar of *Chalicotherium Sivalense*, and the generic accordance was found to be complete. The one (Kaup, *loc. cit.*, tab. vii. fig. 5) is a worn last molar of the left side, broken behind (regarded by Kaup as penultimate). In correspondence with the upper molar, the crown is proportionally broader and less elevated than in the Sewalik species; the anterior edge of the front lobe is not so much inclined, but the point in which it terminates shelves backwards towards the base of the middle internal lobe, as in the Indian fossil; the internal point at the confluence of the two crescents is also considerably elevated, and the outer termination of a posterior talon is discernible; the other tooth is an antepenultimate true molar of the right side. Excepting the greater width and lower elevation of the crown it agrees closely with the corresponding tooth of *Chalicotherium Sivalense* in form and proportional size. It would appear that this accordance runs throughout the

[1] Odontography, p. 602, pl. 135, fig. 7. The specimen is in the British Museum: 'Palæont. Coll.' No. 19,950.

series of lower molars. M. Pomel, to whom the detached lower jaw was submitted in Paris by Sir R. Murchison, was immediately struck with the resemblance. His words (extracted from a communication with which I have been favoured by Mons. Pomel) are:—

'Cette mâchoire inférieure me paraît ressembler en tout point, sous les rapports génériques, avec une pièce découverte à Sansans et qu'on ne peut rapporter qu'à une mâchoire supérieure trouvée dans le même gîte, que j'ai vue dans le cabinet de M. de Blainville et qui est certainement celle du *Chalicotherium*, Kaup. Les molaires ont exactement la même forme générale, et la dernière paraît également avoir manqué de troisième croissant. Les molaires antérieures sont de même plus semblables aux postérieures. Malheureusement, le bord symphysaire a également été brisé.

'Mais il me paraît qu'il y a certainement une différence entre les animaux.'

CHALICOTHERIUM.[1] Kaup.

Char. essent.—Dentes 26: viz. inc. $\frac{0\cdot0}{0\cdot0}$; can. $\frac{0\cdot0}{1\cdot1}$; mol. $\frac{6\cdot6}{6\cdot6}$. Pro primoribus, laniariisque superioribus diastema: horum inferiores cuneiformes. Molarium superiorum 3 anteriores transversim compressi, condensati; posteriores maximi, quadrati, coronâ complicatâ quadricuspide; inferiores bilunati, postremô conformi.—Oculi depressi. Nasus ? Palmæ et plantæ verosimiliter tridactylæ.

Genus inter Pachydermata extinctum in Europæ et Asiæ Australis fossariis obvium, dentium primorum defectu insignitum: hinc *Anoplotherio*, illinc *Rhinocerotidi* affine: maxillæ superioris formâ, Ruminantia, cæteroquin valde diversum, simulans.

1. *Chal. Goldfussi.* (Kaup.) Statura Rhinoc. Javanici. Olim in Germania et Gallia degebat.

2. *Chal. Sivalense.* (Falc. & Caut.) Staturâ inter Rhinoc. Javanici et Tapiri Indici medium. Olim degebat in India Orientali.

[1] From χάλιξ, *calx*, or pebble, and θηρίον, the name being probably suggested by the gravelly beds of Eppelsheim, in which the European fossil was discovered by Kaup. Cuvier's *Anthracotherium* is a similar case.

APPENDIX TO MEMOIR ON CHALICOTHERIUM.

Extracts from Dr. Falconer's Note-books.

Darmstadt Museum: September 4, 1856.

Examined a beautiful specimen, hitherto unfigured, of the left upper jaw of *Chalicotherium Goldfussi*, nearly in every way the counterpart of our Sewalik specimen figured in the Geological Proceedings (Pl. XVII. figs. 1 and 2). It comprises the same width of palate, the same height of mutilated maxillary, and the same number of teeth; but older, i.e. in more advanced detrition; the correspondence in every general respect is very remarkable. The specimen contains six molar teeth in continuous line, i.e. 3 premolars + 3 molars.

The antepenultimate premolar (first) is exceedingly like the Sewalik figure, being small, nearly triangular, with a main (outer) pointed cusp, which is worn down as in the Sewalik specimen, with the small insular detached interior cusp (placed at the posterior end developed into a lobe), continued forwards in a basal bourrelet, which terminates anteriorly in a small lobule, as in the Sewalik figure. *This tooth is proportionally much less worn* than the three next, which are ground down so as to involve the insular cusp in one common disc (i.e. very much worn). The penultimate true molar is less worn, having the cup of the insular disc untouched. The cusp of the last molar is perfectly intact, but the outer main ridges (the chevrons) are well worn.

The two last molars are, as in the Sewalik specimen, nearly of a size; the teeth then diminish most rapidly in front with the *anisodon* characters.

The others diminish very rapidly from the second true molar. The three anterior premolars very much compressed, i.e. broader than long; the first nearly triangular.

	Inches	Mètre
Length of series of 6 molars	7·1	·18
Ditto 3 true molars	5·0	·124
Ditto 3 premolars	2·18	·055
Length of last true molar	1·9	·048
Width of ditto	1·9	·048
Length of penultimate molar	1·7	·042
Width of ditto	1·9	·047
Length of antepenultimate	1·3	·032
Width of ditto	1·45	·035
Length of last premolar	0·8	·020
Width of ditto	1·2	·028
Length of 2nd premolar	0·7	·016
Width of ditto	0·9	·022
Length of 1st premolar	0·7	·017
Width of ditto	0·7	·017

N.B. Inches taken roughly with tape.

Memo.—The anterior (antepenultimate, or first) premolar is distinctly two-fanged, and the fangs are more divergent on the inside than on the outer.

Saw no cast, nor the original of Kaup's canine, fig. 4 of Plate VII. of the Darmstadt fossil; but there is a triangular cusped tooth with a long fang *which must have* had a very oblique, i.e. sloping insertion in the jaw, which may be a canine of *Chalicotherium* belonging probably to left side of upper jaw, or to right side lower. It is much larger than our lower 'canine,' more triangular in section, with an edge behind, and rather blunt in front; apparently unfigured. This supposed canine is larger than the anterior premolar; in our Sewalik (Baker's) head, the lower canine and anterior premolar are nearly of a size.

Memo.—Kaup, in conversation, tells me the supposed canine proved to be an incisor of *Rhinoceros Goldfussi.*

Chalicotherium.—Munich, June 15, 1861.—Most interesting of all the Pikermi collection are a set of specimens of a very large species of the same *genus* as our Sewalik *Chalicotherium.* This is the *Nestoritherium*, Kaup (Beitrage, viertes Heft. 1859), which is figured and described by Wagner (1857) under the name of *Rhinoceros pachygnathus.*

The principal specimen, fig. 15, Plate VII., execrably drawn, consists of the greater part of a cranium from the sinciput on to the middle of the diasteme, and the greater part of the nasals; but the whole of the sphenoidal and occipital portion wanting. The entire chaffron, with greater part of the nasals, is present, but so crushed down upon the maxilla of the left side, containing the molars, that not a trace even of an orbit can be detected. It looks as if the specimen never had had an orbit! Frontal portion behind the last molars broad and concave, longitudinally and across, as in an Arab horse. Cerebral box (*boîte*) broad and without ridges over the temporals, something as in the genus *Equus.* Nasals also seem as like those of a horse, but the lower extremities broken. The animal very old (from the teeth), and no trace of suture between nasals and frontal; but a line of groove marking the internasal and interfrontal suture. The maxillary with molars, on right side, entirely wanting. No determinable trace of a sub-orbital foramen, or of incisive bones.

Dentition of left side.—All the molars are *in situ*, viz. three true molars, three p.molars = 6 together, with 1·2in. in length of a sharp diastemal ridge in front of p.m. 2. The animal was very old, all the teeth being ground down to a flat surface, except the last; and of the last the isolated cone is ground down low; but the posterior angular fissure-like valley is intact. The teeth in general form, and *anisodontine* character, exactly like the Sewalik specimen which has the orbit, right side; but there is this difference, that in the Pikermi specimen the molars have a very strongly pronounced internal basal bourrelet showing in the premolars, as in hippopotamus, and in the last molar, a very bold, broad, sharp, bounding keel.

The dimensions are as follows:—

	Inches
Extreme length of fragment	18·
Length of line of 6 molars	9·4
Ditto of 3 true molars	6·3
Ditto of 3 premolars	3·1
Length of p.m. 1	0·9
Width of ditto	0·95
Length of p.m. 2	1·1
Width of ditto	1·42

	Inches
Length of p.m. 3	1·22
Width of ditto	1·5
Length of true m. 1 (outer side broken)	1·65
Length of true m. 2 (outer side)	2·3
Width of ditto (greatest at middle)	2·0
Length of true m. 3 (outer side 2·65)	2·7
Width of ditto (greatest in front)	2·
Length of diastemal edge remaining	1·2

Memo.—The teeth, both upper and lower, show distinctly on their comparatively thin enamel the parallel fibrous lines, as in *Rhinoceros.*

The greater part of the palate is present, and the sinus has its bottom in a line with the extremity of the last molar.

The anterior premolar (p.m. 1) is sharp and wedge-shaped in front, wide behind. No trace of disc of pressure in front; basal bourrelet and isolated cusp shown by disc; crown ground down low.

P.m. 2, worn down to an uniform disc, with slight remains of two fissures.

P.m. 3, much worn, and like 2; bourrelet well marked.

N.B. The outer surface of the three premolars quite flat, without chevrons.

T.m. 1, antepenultimate true molar, much worn; disc of isolated cone confluent with the rest of the surface; outer surface broken off, and the W-shaped chevrons lost.

Penultimate true molar worn down low (lower even than in the Sewalik true mol. 1); the disc of its conical cusp confluent in front with main disc, but distinct behind. The outer surface shows very markedly the W pattern and bulges of the Sewalik form. The posterior angular fissure ground down, leaving only a slight crescentic depression.

The last true molar shows the disc of the cone distinct, or nearly so (a fracture and chasm in the specimen conceals this partly). It shows the chevrons and bulges very boldly; and the posterior angular valley, with its bounding ridges, quite intact and shaped exactly as in the Sewalik species.

In a general way, the Pikermi species differs from the Sewalik one in having the last molar longer than the penultimate, the reverse of which occurs in the Sewalik. Also in the latter the true molars are broader in reference to their length than in the Pikermi.

The diastemal ridge is very sharp, and there are no indications of canines; and none of the incisive slips of the Sewalik form.

Of the lower jaw there are two specimens: one young, with both rami and symphysis, and milk dentition; the other very old, with both rami, six molars on either side much worn, the whole of the symphysis, the diastemal edge on left and right, and the greater portion of the edentulous incisive margin.

The following are the principal dimensions:—

	Inches
Extreme length of specimen	15·
Length of line of 6 molars	8·9
Ditto of 3 true molars	6·
Ditto of 3 premolars	2·9
Length of diasteme to incisive border left side	2·85
Width *between diastemal* ridges at base	1·3

	Inches
Length of p.m. 2	0·7
Ditto of p.m. 3	1·0
Ditto of p.m. 4	1·18
Ditto of true m. 1 (middle)	1·55
Ditto of true m. 2 (outer)	2·1
Ditto of true m. 3	2·3

P.m. 2 is the least worn of all—compressed; no disc of pressure in front.

P.m. 3 has crown mutilated both sides.

P.m. 4 shows the two crescents, as in rhinoceros: crown well worn.

T.m. 1, or antepenultimate, is very much worn: crescents confluent.

T.m. 2, (penultimate), also well worn; crescents confluent and yielding cordate discs.

True m. 3, less worn, discs nearly confluent, somewhat reniform in character.

All these molars show a distinct basal bourrelet outside at base.

The diastemal ridge nearly entire on left side, very sharp, and shows not the slightest indication either of a detached first premolar or of a canine. Further, the left half of the incisive border present and entire, without the slightest trace of either incisive teeth or their alveoli.

The symphysis commences in a line with the posterior third of p.m. 3, and the total length of symphysis to incisive border is about four inches, or a little more.

The diastemal ridges rise into a sharp edge, leaving between a deepish gutter or spout, which expands a little as in the Sewalik species towards the incisive border—but only a little.

The most remarkable character of all is, that the lower surface of the symphysis is contracted forwards into a sharp keel as in a boat, which terminates suddenly at 2·7 inches in front of the anterior premolar, and then the short incisive margin projects forwards to its slight expansion, without a trace of this keel! showing a very remarkable *edentate* character. Nothing of this keel seen in the Sewalik species, and it is very different from Lartet's specimen, called *Chalic. Lartetii* by Kaup.

Certainly no lower incisives, as in Lartet's jaw.

On the Inconvenience of Retaining the Dichobunes in Anoplotherium.

Great inconvenience arises from retaining the *Dichobunes* in *Anoplotherium*, and quoting the species under the name of that genus, the true *Anoplotheria* being allied to rhinoceros in their dentition with the natatory habits of the otter in the case of *A. commune*, while some of the species ranked under *Dichobune* are nearly indistinguishable from the musk deer. Such heterogeneous materials are too much for the limits of any genus. Cuvier considered his arrangement of them as merely provisional—'Les deux espèces suivantes (*A. murinum* and *A. obliquum*) sont encore plus douteuses, car il ne serait pas impossible qu'elles appartinssent à de petits ruminans, et toutefois jusqu'à ce qu'on en ait la preuve rigoureuse, on puit les laisser dans les Anoplotheriums, au moins pour la nomenclature." Cuvier even regarded *A. leporinum* as a provisional name only (Ossemens Fossiles, tome iii. p. 70). The inconvenience alluded to has been felt in the case of Mr. Pratt's fossil, from

Binstead (Geol. Trans., Series II. vol. iii. p. 451), which is the *A. cervinum* of Professor Owen (*idem*, vol. vi. p. 45), admitted on all hands to be prodigiously like a musk deer, while *Anop.* (*Chal.*) *Sivalense* and the *Chalicotherium Goldfussi* press in the direction of *rhinoceros*. Should the two separate cannon bones have proved constant in all the species now ranked under Anoplotherium and been limited, as Cuvier imagined, to them, the character might have been better used to define a group of genera than as the means of defining a genus. But we have ascertained the singularly interesting fact that the united cannon bones so eloquently handled by the illustrious Cuvier in the 'Discours Préliminaire' as invariably present in the ruminants are subject to exceptions, and no longer 'as certain as any conclusion in physics or morals;' nor a mark 'surer than all those of Zadig' (Disc. Prélim. p. 49). We have had an opportunity of examining the skeleton of the African *Moschus aquaticus* (Ogilby) described from a *living specimen* by Mr. Ogilby in the Zoological 'Proceedings,' and we find that the metacarpals *are distinct along their whole length*! with the succentorial toes as much developed as in a Peccary. The fore leg, from the carpus downwards, is indistinguishable from that of a Peccary! We had previously ascertained the same structure in the foot of a fossil ruminant from the Sewalik hills, but believe that the present is the first announcement of the fact in regard to an existing form of this order (see *antea*, page 196). The deviation from the ordinary ruminant type indicated by the foot is borne out by a series of modifications in the head, bones of the extremity and trunk, all tending in the direction of the Pachydermata. Inasmuch as the Dorcatherium of Kaup breaks down the empirical distinction as to the teeth between the Ruminantia and Pachydermata, so does the *Moschus aquaticus* in regard to the feet.—[H. F. 1843.]

XI. ON THE FOSSIL CAMEL OF THE SEWALIK HILLS.[1]

BY HUGH FALCONER, M.D., AND CAPTAIN P. T. CAUTLEY.

AMONGST the most interesting of the fossil remains of Mammalia, which have been found in the Sewalik strata, the Camel may, undoubtedly, take up a high position. Independently of the speculations which the remains of this genus would lead to, relatively to the form and features of the country previously to their entombment, the circumstance of the Camel having been up to this period a desideratum in fossil zoology adds very considerably to the interest of the present discovery.

The only[2] remain which we find noted is in Cuvier's 'Ossemen's Fossiles,' where a reference is made to the *Merycotherium Sibericum* of M. Bojanus, which Cuvier decides to be an undoubted species of Dromedary. This remain consists of three teeth brought by a merchant from Siberia; the place or stratum in which it was found is unknown, and Cuvier's remark—'Si les trois dents que M. Bojanus vient de publier sont effectivement fossiles'—throws an uncertainty even on its antiquity.

In the identification of the Sewalik fossil there can be no doubt; and although we should have preferred delaying this paper until we had a perfect skull, we may, perhaps, be excused for entering upon the description, since the portions of the skeleton we already possess, including parts of the skull, are sufficiently marked to remove all doubts as to the animal to which they belonged.

The Camel is placed in systematic arrangements at the

[1] Reprinted from the 'Asiatic Researches,' vol. xix. p. 115. 1836. Subsequently to the publication of this paper, many additional remains of the Sewalik camel, including the vertebræ and the bones of the anterior and posterior extremities, were figured in the 'Fauna Antiq. Sivalensis' (Plates lxxxvi. to xc.), to the description of which the reader is referred.—[ED.]

[2] Ossemens Fossiles, tom. v. part ii. p. 507. Besides the *Merycotherium*, Cuvier also notices in the same article a fossil femur, of which he says 'qui ressemble aussi beaucoup, dans ce qui en reste, à celui d'un chameau.' A drawing of the specimen, which was found near Montpellier, was sent by M. Marcel de Serre to Cuvier. Our information does not extend later than the third edition of the Ossemen Fossiles, in 1825.

head of the Ruminantia. In common with the rest of the family it has a compound stomach. Its molars have the form characteristic of Ruminants, and its skeleton generally is constructed on the same plan. But the skull differs very materially in form from that of the horned Ruminants; and we see in the less complete anchylosis of the metacarpal and metatarsal bones, and in the greater division of the carpus and tarsus, an approach to a higher family among the Mammalia. The anomalous character of the pseudo-canines, the presence of incisors in the upper jaw, the thickness of skin and horny soles of the feet, show a strong affinity with the Pachydermata. This affinity is greatest with the Solidungula, which the camels approach by their more divided carpus and tarsus; while the former approximate to the camels by their soldered metacarpals and metatarsals.

In drawing a comparison between the skull of a Camel and that of a horned Ruminant, the peculiarities of the former are exhibited in the great width and massiveness of the cranial portion, contrasted with that of the muzzle, which is slender; the position of the orbit is more central, and its edges more prominent, owing to the elongation of the cranium and to the greater development of the temporal fossa.

We cannot do better, however, than follow Cuvier in his observations on the same subject, who, in drawing his comparison with the separate bones of the head, remarks—'In the true Camels the occipital crest is more elevated, and the temporal fossæ more hollowed than in the Lamas, this development being nearly as great in the Camel as in the Carnivora; the occipito-temporal suture is considerably in front of this crest; the nasal bones are narrower at their bases, and a much larger space intervenes between the small membranous portion situated at the angle of the nasals and the lachrymal bone, a very small portion of which is exposed, and which does not even extend to the internal sub-orbital foramen in the orbit.' These remarks are applicable to the Ruminants generally, as well as to the Lamas, although the passage from which we have made the quotation is intended for the latter. We may add two other points in which a marked difference exists between the skull of the Camel and the horned Ruminants: first, in a greater depth of maxillary bone, and a consequent elevation of the nasals; second, in the external nasal aperture being provided with three pairs of bones, the nasals and intermaxillaries being separated; this intervening space is a general feature in the Camel, although subject to great variations in extent. We have seen specimens with the nasals and intermaxillaries separated by a space of two inches, and others again with only one quarter

of an inch of the maxillary bone appearing on the nasal aperture. In the horned Ruminantia this peculiarity is only observable in the Yak and Auroch.

We have considered the above observations applicable in pointing out the differences that exist in the osteology of the Camel's head and that of other Ruminants, previously to entering upon the teeth; as with these two points fully explained, the identification of our fossil is placed beyond all doubt, and it will only remain then for us to show the differences which it exhibits.

It has been before noted that the anomalous character of the teeth is one of the points connecting the Camel with a higher family. The molars, however, are, as is normal in Ruminants, in number twenty-four; six on each side in the upper, and the same in the lower jaw. The first molar, which, from having the simple and pointed form of a canine tooth, has by some naturalists been termed a second canine, is one of the chief peculiarities of the Camel. It is situated at some distance from the remaining molars, which, in number five, are in a continuous series; in the lower jaw the second molar, or that which may be considered the first of the series, is described by Cuvier as falling out at an early age; and, not being replaced, it leaves a series of four teeth only.

We have examined a number of skulls of the common or Arabian Camel, and have only found one example of the existence of this second molar in the lower jaw; the series in all other cases consisting of four, with a wide intervening space between the first and third. That it is a part of the true series is undoubted, from its existence in the specimen above alluded to. It is exceedingly small and rudimentary. Its position is central on the space between the first and third of the whole series.

The skull in which we have observed this small and deciduous tooth is from a fine specimen of the Camel procured at Hissar. The animal to which it belonged was full-grown, we should say somewhat passed the adult state, judging from the bones of the cranium being anchylosed, and a consequent absence of sutures. There is a greater development of all the distinctive characters in this specimen, in depth of maxillaries, comparative dimensions of the cranial and facial portions, &c., arising from the superior growth to which the animal has attained, and from the superior class of animal from which it was selected; and the space occupied by the maxillary bone in the external nasal opening is also smaller than we have observed in any other specimen.

In the upper jaw the line of molars consists of one sharp pointed tooth similar to a canine, and situated at some dis-

tance in front of the others, which are in a continuous series; the two first being single-barrelled, and the three last, or the three true molars, double-barrelled.

In the lower jaw a sharp pointed tooth, corresponding with that in the upper jaw, is situated in the same way; and takes the place of the first in the series. The intervening space between this and the continuous line contains the second or small deciduous molar. The remaining four teeth are placed together, the first of these (or third of the whole series) consisting of a similar cylinder, and the three permanent molars, as is usual with the Ruminants, being double-barrelled with the exception of the last, which is triple-barrelled. Finally, as in the Sheep and Antelopes, the cylinders are well defined, and without any approach to accessory pillars.

There are two canines in the upper jaw, as we find in another section of the Ruminantia.

The presence of incisive teeth in the upper jaw is peculiar to the Camel as a ruminant. Of these teeth there are two, corresponding in position to the outer incisors, and similar in form to the canines. In taking a lateral view of the skull this similarity of form in the incisor, canine, and first molar, gives the appearance of three canines in the upper jaw.

In the lower jaw there are, as is normal in the family, eight incisors, differing in form from those of other genera—the outer ones taking the simple and pointed form as described above, and the six intermediate ones being more regular in proportions than is usual in Ruminants, and having on each side a nick or hollow on the grinding surface.

The teeth of the Camel, then, are as follows:—

Upper Jaw.—2 Incisors.
2 Canines.
12 Molars, two of which are pointed and have been termed second canines.

Lower Jaw.—8 Incisors, two of which are pointed.
12 Molars, two of which are pointed, and two deciduous at an early age.

The chief peculiarities of the skull are—

1. Narrowness of muzzle.
2. Advanced position and prominence of orbits.
3. Elevation of sagittal and occipital crests and development of temporal fossæ.
4. Narrowness of nasal bones at the posterior extremity.
5. Extreme depth of maxillary bone, producing an arched appearance in the nose of the animal.
6. Form of sphenoid and basillary portion.
7. Number of bones on the external nasal aperture.

This summary brings us at once to the comparison of our fossil species with the existing *Camelidæ*.

In pursuance of the rule that we have proposed to follow in naming the new species so as to ally them at once to the mountain series, whence their remains have been obtained, we propose calling the largest, and that nearly approaching the Indian species, *Camelus Sivalensis*; for the second or a smaller species, the description of which we shall enter upon more fully hereafter, and which may perhaps have been more closely allied to the Lama, we propose the name of *Camelus antiquus*.[1]

Camelus Sivalensis.

Of the *Camelus Sivalensis* we draw our description from the remains both of the skull and of the bony structure of the animal generally. We have at present only portions of the skull to guide us. The remains of the lower jaw, however, are perfect, including the coronoid processes. The articulating ends of bones are in sufficient abundance, and in a sufficient state of preservation to enable us to form a very tolerable idea of the size and height to which the animal must have attained.

To commence with a comparison between the fossil skull and that of the Dromedary or Common Camel in use in the Bengal Provinces. From the imperfection of our fossil fragments, and the sutures not being distinctly traceable in most cases, we must be satisfied with a view limited more to the general character than to the detailed boundaries of the bones; yet it is fortunate, that in some cases where these boundaries are especially required as a distinctive character, as in the naso-frontal and naso-maxillary suture, our fragments, imperfect as they are, have been provided with them.

The form of the skull, position of sutures (as far as our fossil fragments exhibit), and the teeth, both in number and character, very closely resemble the existing species above referred to. We draw our comparison from a fragment consisting of the posterior portion of the nasals and maxillary bones, with the frontal to the posterior border of the orbits. This fragment would alone establish the genuine position of the animal, and in the absence of a perfect skull we could not have possessed a specimen more applicable to our present purpose. This fragment, in fact, contains three of the most prominent points in which the Camel differs from all other Ruminants. Here we have the contrasted breadth of the frontal and facial bones, the extreme narrowness of the posterior extremity of

[1] Only one species of Camel, *C. Sivalensis*, was subsequently figured in the 'Fauna Antiqua Sivalensis.'—[Ed.]

the nasals, and the great distance between that point and the anterior border of the orbit, distinctly shown. In the fossil there is a strong resemblance in all these points to the species now existing; the swelling of the frontal is as highly developed, and the deep superciliary notch as well defined. The narrowness of the nasal bones on their approach to the frontals is well marked, as also that space occupied by the membranous portion in rear of the nasal bones; and the superciliary foramina correspond in size and position, being placed as remote from the orbit as in the living animal. In viewing this fragment laterally we observe that the orbit has an excess of length on its antero-posterior diameter, the orbit of the existing Camel being either a perfect circle, or having the excess of length in its vertical dimension (Plate XVIII. fig. 1, or F.A.S. Pl. LXXXVI. 4 *a*). The mutilated state of this fragment (see fig. 4, Pl. LXXXVI., F.A.S., giving an upper representation of the fossil) does not admit of remark or comparison further than that the animal to which it belonged was far advanced in age, and had arrived at that period and state of dentition when the obliteration of the crescentic lines was complete, and when the grinding surface consisted of ivory with an imperfect margin of enamel. The second or third false molars, or those with a single cylinder, are here in position; exhibiting a remarkable affinity to those in the existing Camel both in form and in the contrasted obliquity of wear (to front and rear respectively in the first and second teeth), which is such a peculiar feature in the old animal.

Fig. 2 of Plate XVIII. (or F.A.S. Plate LXXXVI. fig. 3) is a representation of another fragment; both jaws being locked together, but the anterior and posterior extremities, with the upper surface of the skull, wanting. The animal from which this remain originated was young—its ultimate permanent tooth not completely developed, and the third milk molar still in position. The general character is that of the present Camel, the form of maxillaries, thickness of lower jaw and external appearance of teeth, corresponding as closely as two skulls of one species would do in the animal now existing. The position of the sub-orbital foramen, however, is rather higher up on the maxillary, and the diminution in depth or tapering of the lower jaw is not so considerable as we observe to be the case in the existing Camel.

Figs. 3 and 4 of Plate XVIII. (or F.A.S. Pl. LXXXVI. figs. 5 and 5 *a*) give us a still further insight into the form of the head of the fossil Camel. The lower jaw (with the exception of the upper portion of the ascending branches including the condyle and coronoid processes) is quite perfect; and the lines of molars of the upper jaw are also in position.

DESCRIPTION OF PLATE XVIII.

CAMELUS SIVALENSIS.

Fig. 1. Lateral view of cranium of *Camelus Sivalensis*, one-fourth of the natural size. The specimen is in the British Museum, and is copied from a drawing, by Mr. Bone, in the Fauna Antiqua Sivalensis. Plate LXXXVI., fig. 4 *a*. (See pages 232 & 533.)

Fig. 2. Is of another specimen in the British Museum, showing both jaws of *Camelus Sivalensis* locked together, and one-fourth of the natural size. The figure is copied from Plate LXXXVI., fig. 3, of the F. A. S. (See pages 232 & 532.)

Figs. 3 and 4. Are horizontal and profile views of the lower jaw of *Camelus Sivalensis*, one-fourth of the natural size, and copied from figs. 5 and 5 *a* of Plate LXXXVI. of the F. A. S. This specimen is also in the British Museum. (See pages 232 & 533.)

Fig. 5. Fragment of upper jaw of *Camelus Sivalensis*, containing the second and third true molars, three-eighths of the natural size. In the British Museum. Copied from Plate LXXXVII., fig. 3, of the F. A. S. (See pages 234 & 533.)

Fig. 2.

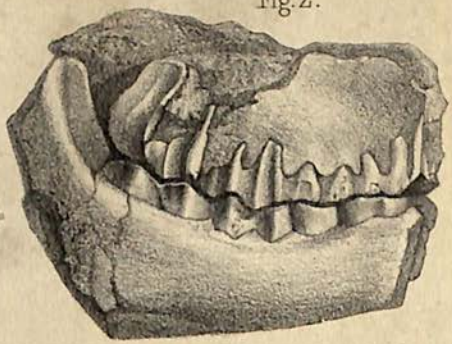


Fig. 5.

Fig. 1.

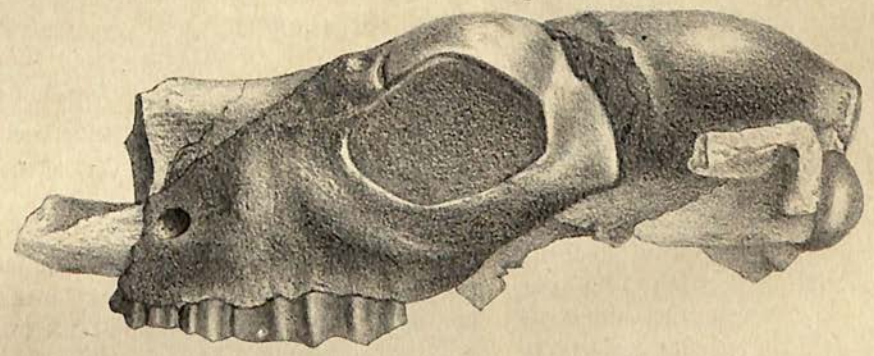


Fig. 4.

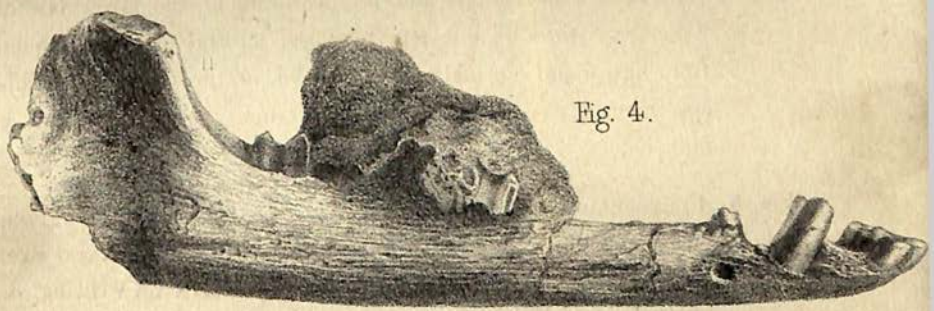
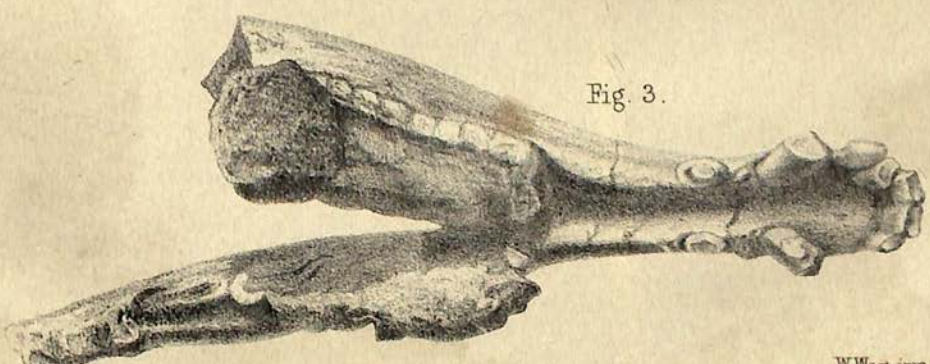


Fig. 3.



W. West imp.

C.R. Bone del. J. Dinkel lith.

Camelus Sivalensis.

Here we may express a regret as to the want of careful superintendence in excavating and removing these fossils from the stratum. It is possible, in the present case, that the whole of the upper portion of this specimen might have been obtained had proper care been taken in removing the circumjacent matrix. It will be seen that the upper portion has been as it were cut off on a line with the alveoli of the upper molars, leaving not only them but also the upper canines in position.

Fig. 5[1] represents the lower jaw of the existing Camel, and placed in juxta-position with the fossil will convey a tolerable idea of the form and character of both. The measurements of the lower jaws are annexed.

Dimensions, Lower Jaw	Fossil		Existing from Hissar		Existing from Suharanpoor	
	In.	Mèt.	In.	Mèt.	In.	Mèt.
1. Extreme length from alveolus of incisors to rear of ramus .	16·8	·428	15·0	·382	15·2	·387
2. Ditto expanse of alæ to the rear	8·1	·25	6·4	·162	6·2	·157
3. Ditto length of symphysis .	5·4	·116	5·325	·135	4·95	·125
4. Width of jaw over first or pointed molar . . .	2·1	·052	1·95	·050	2·0	·050
5. Length of molars in series .	5·9	·15	5·4	·137	5·2	·132
6. Distance between 1st or pointed molar and the 3rd or 1st of the series . .	2·95	·075	2·575	·065	2·6	·066
7. Extreme depth of ramus at the ascending angle . . .	4·25	·108	—	—	4·0	·101

This fossil is the remain of a very old animal; the canines and pointed teeth are worn down to a flat surface, and the molars which can be partially examined, from the circumstance of the two jaws having been fossilized obliquely on each other, appear to have lost all their enamel excepting the exterior border. We before stated that, although the cranium and facial bones were entirely removed, the lines of molars on both jaws were in position; the animal had, partly from age and partly from accident, lost the first molar from the right side of the upper jaw. This tooth must have dropped out at an earlier period than nature had ever intended, and the coronal surface of the corresponding tooth in the lower jaw, for want of the wear which it ought to have had under the natural course of detrition, is distinctly marked with its crescentic lines of enamel. The fall of the tooth has further led to a tendency on the part of the rear teeth to incline forwards and partially occupy its place; this inclination had so far

[1] Refers to Plate xx. vol. xix. of 'Asiatic Researches.'—[Ed.]

advanced, as to prevent the posterior cylinder of the tooth in the lower jaw from undergoing any change, the front and foremost cylinder only of this penultimate tooth having undergone this singular alteration and arrived at this diseased form.

In referring to the table of measurements above given, the excess in size of the fossil is the most prominent feature, but the relative dimensions of the different parts, with one exception, bear a close affinity to those of the existing Camel. In the jaw of the latter there appears to be a greater depth at the alveolus of the ultimate molar at the commencement of the ascending branch, which may possibly result in some degree from age and the more perfect development of the teeth; but in other respects the resemblance is striking. The exception to which we refer is in the second measurement, showing the breadth between the rami, or ascending branches to the rear, a difference of some importance, as it involves in the structure of the cranial portion of the skull an increase of width, and a greater distance between the articulating or glenoid surfaces for the condyles of the lower jaw. We are borne out in the correctness of this inference, by the remains of our second species of Camel, which fortunately is very perfect in the cranium, and where the breadth and form of this region in comparison with that of the existing Camel are very different. To this, however, we shall refer in its proper place, satisfying ourselves with the conclusion that the *Camelus Sivalensis* and the *Camelus antiquus* corresponded in this respect, and that the former differed from the existing Camel in the form and excess of width of the cranium. In comparing the teeth of the fossil represented in Plate XVIII. figs. 3, 4, and 5, with those of the *Camelus dromedarius* we observe no difference, excepting that which may have arisen from their difference in age. That of the fossil must have been considerable, as may be observed in the wear and flattened surface of the fourth or pointed incisor. The intermediate incisive teeth have been slightly disarranged in the matrix; and it will be observed in the drawing that one of these teeth has been displaced, and is now situated above, embedded in the rock. The grinding surfaces of all the incisors are much worn, and all marks of the lateral nick completely obliterated. On the opposite side to that represented in the plate, the canine tooth of the upper jaw is situated in position with its point downwards, embedded in the mass of matrix, which, it may be observed, reposes on the anterior parts of the fossil. This canine is much worn both on the point and on the anterior side; and its resemblance to that of the Camel of the present day is sufficiently close to make any further comparison unnecessary.

Figs. 6 and 6 *a* (Pl. LXXXVII. F.A.S.) are portions of the

lower jaw of the skull, a fragment of which is represented in fig. 1 of Plate XVIII. The mass from which these remains were recovered was carefully broken up by ourselves, and the broken pieces united afterwards. A great portion of the cranium appears to have been disintegrated and so mixed up with the matrix as to make all attempts at a separation ineffectual. The anterior part of the lower jaw has suffered in this way, but the extreme good fortune of rescuing that portion represented in the figures above alluded to, consisting of the rami of both the right and left side, with the condyles and coronoid processes entire, is ample compensation for the loss, more especially as the incisive extremity was already in our possession, and we were only in want of the articulating and coronoid processes to complete the jaw. The difference in form of the fossil will be observed on a reference to fig. 5,[1] which is a representation of the lower jaw of the existing Camel. In giving the measurements, we place in juxta-position those of the Hissar and Suharanpoor Camels before referred to.

	Fossil		Existing Hissar		Existing Suharanpoor	
	In.	Mèt.	In.	Mèt.	In.	Mèt.
Total depth from top of coronoid process to lower border of jaw	8·3	·211	9·2	·233	7·9	·20
Ditto from surface of articulating condyle to lower border of jaw	5·45	·138	8·1	·205	6·4	·162
Ditto from heel to lower border of jaw	3·6	·091	6·0	·152	4·7	·119
Depth from top of coronoid process to upper margin of articulating condyle	2·85	·072	1·1	·028	1·5	·038
Breadth of condyle on transverse measurement . . .	1.7	·044	1·65	·042	1·6	·041

The fossil ramus has more the form of that of the Ox than of the Camel; the slenderness of its proportions resembles that of the *Cervidæ* more than of the *Camelidæ*, to which it belongs; and were it not for the heel or step on the posterior ascending margin, which as the generic mark establishes its position, we should have been at some loss in recognizing as the remain of a Camel, a fragment bearing in its external appearance so strong a resemblance to the Ox, Deer, or Antelope. Independently of the heel, the Camel now existing is rather peculiarly formed in this part, in comparison with other Ruminants. The Buffalo is that which has the nearest approach to it. In the existing Camel the ascending branch

[1] See note, p. 233.—[Ed.]

rises at nearly a right angle from the line of jaw; it has considerable breadth on its antero-posterior dimension, and its coronoid process is short, straight, and massive. In the fossil Camel the ascending branch is as oblique as in the Ox; it has no excess of breadth on its antero-posterior dimension, and its coronoid process is long, slightly curved back, and slender. Here are points of difference sufficiently striking, but there is a still further difference in the form of the condyle, that of the fossil having a much longer transverse diameter than in the existing Camel; its proportions are much more slender, and the depression on its upper margin much deeper. We may remark, however, that the slenderness of the fossil condyle is only comparative with reference to that of the same genus now existing, and that it bears no resemblance whatever to the condyle of either the Buffalo, Ox, or other Ruminants. The condyles of the two former are much slighter, and the upper articulating surface much narrower than in the Camel.

On the peculiarity of form above described as appertaining to the ramus of the lower jaw, we are naturally struck by the close resemblance it bears to that of the horned Ruminants, and its marked variation from the same bone belonging to the Camel of the present day; and we should be inclined to refer to the extreme length of the coronoid process as a point tending, in all probability, to unravel the mystery, were we not struck with the discrepancies that appear even amongst animals of the same species, in the length and dimensions of this process.

The length and breadth of the coronoid process appear to be distinguishing features in all animals where there is a great depth of the temporal fossa, and great elevation of the zygomatic arch; and also in those animals possessing the power of great lateral motion of the condyle in the glenoid cavity. Amongst the former may be included all the Carnivora and predatory animals; amongst the latter, the Ruminantia, to which only we shall at present refer, although there appears to be considerable obscurity as to the changes that modification of form of this process entails upon the physical economy of the animal.

The *Capridæ*, including Antelopes, appear to have the coronoid process more developed than the Bos; the Bos more than the Camel. We observe that this process in the common Goat, *C. hircus*, is long and broad, and in the *A. Chikarra* long but narrow; in the *A. tetracornis* it is short. In two specimens of the male and the female of the Nylghau (*A. picta*, Pallas), we observe that the female has an exceedingly long coronoid process, much curved to the rear; whereas that of the male is short, straight, and pointed. We could give additional instances, were it necessary, for a want of any rule

of uniformity; in fact, the inferences of the value of this process in establishing any peculiarity in the organization of the masticatory faculties, appear to us, as we before noted, to be clothed in considerable obscurity.

With these remarks on the osteology of the head, we will —after the following table, showing the comparative sizes of the ultimate tooth in the upper jaw of a number of fossils, compared with that of the Camel now existing—proceed to the rest of the bony structure, which, from the strong resemblance that exists between the fossil and modern types, will occupy but a small space.

Comparative Dimensions of the Ultimate or Third Permanent Molar (see Plate XVIII. fig. 5) in the upper jaw of the Fossil and of the existing Camel.

Dimensions	Existing Hissar		1st Fossil		2nd Fossil		3rd Fossil	
	In.	Mèt.	In.	Mèt.	In.	Mèt.	In.	Mèt.
Length on its antero-posterior measurement. .	1·75	·044	1·90	·049	2·00	·050	2·00	·050
Breadth on its greatest lateral bulge . . .	1·00	·025	1·35	·034	1·25	·032	1·20	·030

Of the vertebral column we possess a very perfect atlas, with part of the axis attached to it. The form is precisely that of the corresponding vertebra of the existing Camel, with the exception of an increased development to the ridge on the lower side, and a consequent increase of depression of the lateral surfaces in which the arterial foramina are situated. The shortness of the wings and the conical form of the atlas correspond with that of the existing Camel.

Of the axis we have only a mutilated specimen; the posterior portion is altogether wanting, but the remainder is similar to that of the present Camel.

We possess a number of the lower extremities of both the humerus, and the radius and the ulna—some of them in connected joints, others separate; but we have not been able to detect, amongst the numerous fragments in our possession, the connecting pieces by which the bone in its whole length could be established. We see no difference whatever in these fragments, and in their articulating ends, from those of the existing animal. The anchylosis of the radius and ulna is as complete; the surfaces for the articulation of the scaphoid and cuneiform bones as flat and unmarked by a hollow; and the lower extremity of the ulna is as destitute of an external process for embracing the cuneiform bone of the carpus, as in the existing Camel.

The carpal bones are equally correspondent in form and number—the small bone in rear of the os magnum and connected bone having the same marked and spherical-headed articulation with the scaphoid.

We now come to the metacarpal bone, of which we have a very perfect specimen attached to the end of the radius and ulna by the intermediate carpal bones. We see no difference in form, and no peculiarity requiring remark. We derive data, however, from this, for establishing the comparative size to which the Sewalik Camel arrived. Our dimensions are placed in juxta-position with those of a full-grown and common-sized Camel of the present day:

	Fossil		Existing	
	In.	Mèt.	In.	Mèt.
Extreme length of metacarpal bone from its articulation with the carpals to articulation with the phalanges	18·85	·479	15·85	·403

The extent of non-anchylosis, and the form of the pulleys for articulation with the phalanges, and the phalanges themselves, appear to correspond, and to be equally characteristic in both the fossil and the living Camel.

With the posterior extremities we are not so well provided, and shall content ourselves with a reference to the femur only, of the lower end of which bone we possess a variety of specimens. Of the largest of these we annex the dimensions:

	Fossil		Existing	
	In.	Mèt.	In.	Mèt.
Extreme transverse breadth in condyles . .	4·9	·124	4·7	·118
Ditto breadth from front to rear . . .	5·4	·137	5·1	·130
Ditto breadth between condyles	0·675	·0165	1·075	·027

With the exception of the proximity of the condyles to each other in the fossil, there is no marked difference; all the hollows and protuberances on the bone of the existing animal have their corresponding ones in the fossil. The femur, in its length, also appears to have had as great a curve forward as we observe in that of the Camel of the present day.

This brings us to a conclusion on the comparative differences between the *Camelus Sivalensis* and the *Camelus dromedarius* now existing. Although the fossil fragments from

which this comparison has been derived are not either so perfect or so numerous as we could have wished, they are still sufficiently so for every purpose of comparison; and in some cases we have been even struck with the remarkable perfection of the fossil, considering its soft and, in many cases, imperfectly indurated quality, added to the intimate combination with, as well as adhesion to, the matrix, which consists of a light-coloured clay with a small admixture of sand.

In recapitulation of our above remarks, therefore, we will note that, independent of the peculiarities described as existing in the cranium of the *Camelus Sivalensis*, upon which peculiarities we rest its specific character, there must have been others in its external form. These differences, however, could not have extended far; its general character must have borne a close affinity to that of the same animal of the present day; and although we have proofs of its size having exceeded our existing Camel in a proportion equalling at least one-seventh of its height, we are unfortunately ignorant of the effects that domestication may have caused in the deterioration or otherwise of the *Camelus dromedarius*, especially in a country and amongst a race of people who pay little attention to its improvement, so long as the natural increase is sufficient to supply their wants and add to their comfort. The *Camelus dromedarius*, from which our comparison has been drawn, must not be confounded with the *Camelus Bactrianus*, or Camel used by the Arabs.

For the Camel in all its perfection we must seek the shores of the Caspian, to the hordes and wandering tribes who from generation to generation have looked upon this animal as the only means by which they could exist—as the only means by which communication could be maintained over oceans of sand and miles of desert. If any care be given to the breed of the Camel in its domestic state, we should expect to find it in this quarter; but among the people of India, who use the animal merely as a beast of burthen, and carry on the breed much in the same way as they do with their other domesticated animals, we have no reason to expect any improvement. In the Government stud we have no doubt that all feasible means are exerted to improve the breed, or at least to prevent deterioration, by maintaining a stock from the largest and finest grown animals. It will be noted that one of the skulls referred to in this paper is from the stud, and the person to whom we are indebted for its use as a means of comparison described it as having belonged to a very large male Camel; but here, also, we see no great difference in size, although there are differences in the greater development of the bones

of the head and face. The constant influx of Camels in the whole sweep of the Indus and its branches, from Ludiana to Shikarpur, or even to the Indian Ocean, most undoubtedly keeps up the supply, but does not add anything to the improvement of the species. Indeed, we are inclined to consider that the Camel has deteriorated in size from that to which it attained in its wild and natural character; and should our inference be correct, the dimensions obtained from the comparative measurement of the bones of our fossil species may lead to a very tolerable idea of the size to which the Camel reached, when unshackled by the trammels of man, and leading its existence in the wilds of its own native region.

We regret our inability, from want of specimens, of adding to this comparative statement the dimensions and peculiarities of form of the Bactrian or true Camel with two humps, *Camelus Bactrianus* of authors. The *Camelus dromedarius*, or the Dromedary with one hump, is the animal from which we have drawn our description. In Stark's 'Natural History' the former is stated to be the *longer* of the two; *Camelus Bactrianus* being described as 'about 10 feet *long*,' and *Camelus dromedarius* as 'nearly 8 feet *long*.' We are not aware of the limits upon which the above measurements are drawn; but in taking those of a perfect vertebral column, from the atlas to the last caudal vertebra of the common-sized *Camelus dromedarius*, we obtain a measurement of 9 feet 10 inches. Including the head, the total length of the *Camelus dromedarius* is 11 feet 4 inches; and this must be considered as under the full measurement, from the absence of inter-vertebral cartilages, which connect the vertebræ in the living animal. Stark's specific character evidently leaves an impression of a superiority of size in the *Camelus Bactrianus*. We learn from Elphinstone, in his 'History of Caubul,' that the height of the latter animal is considerably less; that it is shorter and stouter; well adapted for rocky and hilly countries; and, from its shortness of limb, less liable to accident than its tall and slenderly-formed congener.

On the Camels in Afghánistán, the author above-mentioned remarks: 'The Dromedary is found in all the plain country, but most in sandy and dry parts; this is the tall long-legged animal common in India. The Bactrian Camel (which I understand is called Uzhree in Toorkee) is much more rare, and I believe is brought from the Kuzzauk country, beyond the Jaxartes. He is lower by a third at least than the other, is very stout, and covered with shaggy black hair, and has two distinct humps, instead of the one hump as the Dromedary. The Boghdi Camel, in the south-west of

Khorasan, is shaped like the last mentioned, but is as tall as the Dromedary. Even this last varies, the Dromedaries of Khorasan being lower and stouter than those of India.'[1] Again: 'Many Dromedaries are bred here, or at least by the tribes whose residence is partly in Damaun. They are much darker in colour than the common Camel, have shorter and stronger limbs, and are far better calculated for work among hills.'[2]

It would appear from Elphinstone's remarks that there are three species of Camel:

1st. That which has obtained the specific denomination of *Camelus dromedarius*; tall, slender, with one hump, and common to India.

2nd. *Camelus Bactrianus*, or the Bactrian Camel, which is one-third less in height than the former one, stout, covered with black hair, and with two distinct humps.

3rd. The *Boghdi* Camel, resembling in shape the Bactrian, but with the height of the Dromedary or *Camelus dromedarius*.

The Khorasan Dromedary may be considered as a variety of the first species, or *Camelus dromedarius*, with less height but stouter proportions.

In Griffith's 'Translation of the Régne Animal,' notice is drawn to a third species, distinct from the Bactrian and Arabian Camels, in the possession of Ruguere; of this third species, however, the characters are not given. Hamilton Smith, in Griffith's 'Cuvier,'[3] divides the genus into the two species, *Bactrianus* and *Dromedarius*, considering these as the parent stocks from which a number of breeds and varieties have sprung, 'all nevertheless depending on the very trivial distinctions of colour, size, and form;' but the specific characters of these parent stocks differ very materially from those derived from Elphinstone's work before alluded to, most especially with reference to the *Camelus Bactrianus*, described by that author as one-third lower in height than the Arabian Camel. Hamilton Smith[4] says, in describing the *Camelus Bactrianus*: 'His height may be considered superior to the Arabian, and the bulk of his body more considerable. The large breed of this species attains seven feet and a half from the top of the hunches to the ground, the legs are proportionately short, and the body long.' The height of the Arabian Camel, according to the same authority, does not exceed seven feet. 'Those of Turkey are the strongest and the best suited for burthen; those of Arabia and Barbary the lightest; and those of India, where there are breeds for

[1] Elphinstone's 'Caubul,' second edit. 1819, vol. i. p. 280.
[2] *Ibid.* vol. ii. p. 72.
[3] Synopsis Mammalia, vol. v. p. 298.
[4] Vol. iv. p. 48.

both purposes constantly supplied by fresh importations from the north-west, are probably inferior in their class to those more in the vicinity of their original climate.'

We have been desirous of ascertaining the excess of height to which the existing Camel arrives, to form a correct opinion of the proportionate size of our fossil species; and for this purpose have consulted those authorities from whom it was most likely to draw accurate information. The accounts are sufficiently conflicting; but that of Griffith, as an authority on a point of natural history, may be considered as the best and the most properly to be depended upon. Assuming, therefore, that the comparative heights and proportions of the *Camelus Bactrianus* and *Camelus dromedarius*, as shown by Griffith, are the true ones, and that the latter is of a smaller size than the Bactrian Camel, we are still borne out in our conclusions with regard to the excess of dimensions of the fossil or *Camelus Sivalensis*, and that this excess applies generally towards all the species of Camel now existing.

NORTHERN DOAB: *July* 15, 1836.

APPENDIX TO MEMOIR ON CAMEL.

I.—ON THE FOSSIL-REMAINS OF CAMELIDÆ OF THE SEWALIKS. BY CAPT. P. T. CAUTLEY.[1]

'But the most interesting discovery was that of a camel, of which the skull and jaw were found. It is to be observed that no decisive proof of any of the *Camelidæ*—either Camel, Dromedary, or Lama—had ever been hitherto found among fossil bones, although Cuvier had proved certain teeth brought from Siberia to be undoubtedly of this family, if they were really fossil, which he doubted. This discovery in India was therefore extremely interesting, as supplying a wanting genus. But for this very reason, it became the more necessary to authenticate the position of this supposed camel's remains the more clearly, especially as there were abundance of existing camels in the country, which there could not be in Siberia. The Indian account is somewhat deficient in this respect, leaving us in doubt whether the bones, admitted to bear a very close resemblance to the living species, were found in a stratum, or loose and detached.'—*Dissertations on Subjects of Science connected with Natural Theology.* By Henry Lord Brougham, F.R.S., &c. Vol. ii. pp. 213–14. 1839.

It is only within the last few months that the most interesting volumes from which the above is an extract have reached this remote part of India. Long as the extract is, however, its introduction may be permitted, as affording us the opportunity of removing all doubts of the existence of the camel among the Fossil Fauna of the Sewaliks, by

[1] Reprinted from the 'Journ. As. Soc.,' vol. ix. p. 620. 1840.

a few supplementary remarks, which a re-perusal of the original paper published in the 'Transactions of the Asiatic Society of Bengal,' with reference to the paragraph above quoted, renders necessary.

To those who have interested themselves in the discovery of the fossil remains, which has been made in the Sewaliks, it need hardly be necessary to allude to the two very distinct states in which the mineralization has taken place: that in which the fossil is impregnated more or less with iron in the form of a hydrate, and that where the calcareous elements of the bone are nearly or entirely unaltered, and the medullary hollows filled with matrix; the former universally existing in those remains extracted from the sandstone rock, the latter, from the subordinate beds or substrata, either consisting of clay, or of an admixture of clay, sand, and shingle. The difference in external appearance is remarkable, the sandstone fossil being to a common observer an organic substance converted into stone, whereas that which is found in the clay strata not only conveys an idea of a lesser antiquity, but looks like a substance merely in a progressive state of petrifaction.

As the beds of clay, &c., are inferior in position to the extensive sandstone strata, the palm of antiquity rests with the fossils of the clay; these very imperfect and half-fossilized looking remains being evidently of older date than those of the sandstone.

With very few exceptions, the only remains that have been discovered, scattered on the face of the mountains or in the ravines and water-courses which drain them, are those from the sandstone strata. Those from the lower beds appear to be of a quality too little indurated to withstand the effects of weather and exposure. The greater proportion of the latter, amongst which are some of our most interesting genera, viz. Simia, Anoplotheria, Camelidæ, &c., were *exhumed*—removed out of the parent strata in which they were originally embedded. The remains of Ruminants and Rhinoceroses brought to light in this way were singularly striking: numerous crania of both families—in many cases not having shed their milk-teeth—being found closely and compactly embedded together, the stratum of rock being a perfect Golgotha, not of the skeletons of old and worn-out animals, but of those that were cut off when young or in the prime of their existence.

In the osteology of the camel there are certain distinctive marks which at once separate it from the true Ruminantia, laying aside the peculiarities of the cervical vertebræ, in the absence of perforations for the vertebral arteries in their transverse processes, which, with the atlas excepted, is universal in the family, and separates it not only from the Ruminants, but from all other existing Mammalia. There are two very simple points of difference which can never be mistaken by the most careless observer, the first being the want of anchylosis in the lower extremities of the metatarsal and metacarpal bones, that of the camel exhibiting itself in a cleft or separation of the two bones to a distance of two or three inches from the articulating surface, whilst the same bones of the Ruminants are perfectly undivided; and, secondly, the marked distinction existing in the carpal bones of the camel, in the separation of the scaphoid and cuboid, these two bones being joined together in the true Ruminantia.

Of these metatarsal and metacarpal bones, we have forwarded specimens both to the British Museum and to the Geological Society of

London, extracted from the lower beds of the Sewalik strata, as well as from the sandstone rock. Numerous other specimens of the same family have also been sent to England, the more perfect remains of crania being still in our possession, although ultimately intended for the British Museum.

The most valuable remains of *Camelidæ* which have as yet been discovered in these hills, and which were figured in the 'Transactions of the Bengal Asiatic Society,' *were dug out in my presence.* The stratum in which they were found consisted of a sandy clay, inclined at an angle to the horizon of about 20°; the position being about half a mile north-east of the village of Moginund, which lies at the foot of the range, and the elevation about 400 or 500 feet above that village. These fossils were removed by a working party over whom I was standing, and taken to my camp immediately afterwards. There can be no demurrer on their being fossil remains, for even had they not been exhumed before me, their state of fossilization is a proof of their not having belonged to the existing family; and the position in which I found them was such that, laying aside their being a part of an inclined stratum of rock, no camel of the present day, at least, could have reached such an awkward locality, the excavation having taken place at the head of a deep ravine, terminating in a slip, in a wild precipitous region, far away from the habitation of man, and far removed from even the grazing ground of village cattle.

In the paper above referred to, certain specific differences are noted between the fossil and existing camel, which, *a fortiori*, establish the discovery of the animal in the former state. As these appear to have been overlooked by Lord Brougham, I will, in referring your readers to the memoir in question, note that the most remarkable points of dissimilitude were in that portion of the cranium connected with the lower jaw, the breadth between the articulating or glenoid surfaces for the condyles of the latter being much greater than that in the animal now existing—a peculiarity not confined to one solitary specimen, but common to others, amongst which was a very perfect cranium of a second species, for which we proposed the name of *C. antiquus*, procured from the sandstone strata. With the marked difference above alluded to, it was natural to expect some modification in form to the condyles and rami of the lower jaw. In this we were not disappointed. The obliquity of the ascending branches similar to that of the ox, their form, and the excess of transverse diameter of the condyle, were points of great difference between the fossil and living animal, and in total correspondence with the peculiarities of the cranium. It will be observed that the difference of structure in the skull is by no means of trifling importance, and, as far as the subject of this paper is concerned, is evidence that the bones found by us could never have been the remains of the animals now existing in India.[1]

That the camel lived at the same time with the Sivatherium, Anoplotherium, Simia, Hippopotamus, Rhinoceros, and with the very prototype of the Crocodiles and Garials now abounding in the great rivers

[1] At the lower extremity of the metatarsals and metacarpals the cleft appears to be somewhat less in the fossil than in the existing camel; in the latter the separation of the points of articulation is somewhat greater, a remark drawn from an inspection of a great number of fossil remains of this part of the animal.

and estuaries of modern India, there can be no doubt, as far as the researches in the Sewalik hills have exhibited proofs.

As a fossil discovery, the camel is of great interest. Its position with regard to the Pachydermata and Ruminants is a link of a now broken chain. The Sivatherium was one, and Mr. Owen's Macrauchenia was another, to explain the mystery and add two links to a broken series. That future discovery will tend still further to prove the wisdom of design is an inference borne out by every succeeding step in palæontological research.

Whether the camel has existed in an originally wild state in any period within the historical era, is a question that has been argued at considerable length. The animal in a state of domestication is spoken of during the early period of the Scriptural writings, and by subsequent authors at all periods of history. It is mentioned by Strabo and Diodorus Siculus as having been found in a wild state in Arabia about the commencement of the Christian era.

Pallas, who argues on the evidence of the Tartars, that the wild camel is found in Central Asia, is met by Cuvier in the well-known fact of the Calmucks being in the habit of giving liberty to all sorts of animals on religious principles. The natives of Hindostan, who act in the same way, and are guided by similar motives, have, in their affection for the cow and ox, given rise to a race of wild cattle perfectly distinct from those of the forest. In the districts of Akbarpoor and Dostpoor, in the province of Oude, large herds of black oxen are or were to be found, in the wild and uncultivated tracts—a fact to which I can bear testimony from my own personal observation, having, in 1821, come in contact with a very large herd of these beasts, of which we were only fortunate enough to kill one, their excessive shyness and wildness preventing us from a near approach at any second opportunity. The wild horses of Southern America are another proof of the tendency of animals to congregate in herds, and assume the character of originally wild animals, although, properly, the offspring of domesticated cattle set at liberty. The proof, however, after all, is merely in the possibility of domesticated animals being able to return again to a state of nature, and assume the functions of their primitive designation.

The object of this paper is merely to establish the fact of the camel having been found in a fossil state in the Sewalik hills, the identification being more complete, perhaps, than that of any other of the numerous genera and species which these hills have made us acquainted with. Judging from the number of the remains of this family in our collections, the camel could not have existed in great abundance, and their proportion to the true Ruminants must have been comparatively small.

Northern Doab: *Sept.* 8, 1840.

II.—Description by Dr. Falconer of Fossil Remains of Camel in Museum of Asiatic Society of Bengal.

From Sewalik Hills.

No. 595. *Camelus Sivalensis.*—Fragment of 7th cervical vertebra, comprising the body, with the superior transverse processes attached;

the oblique processes and neural arch broken off. Both articular surfaces shown; the inferior not completely synostosed, showing the animal to have been adult, but not aged. The body, inferiorly, is more curved than in the corresponding bone of the dromedary, and the median ridge less prominent. Also, the length of the body, posteriorly, from the offset of the transverse process to the border of the articulating cup, is considerably longer than in the dromedary. The upper articulating head is more globular, and the body proportionally narrower and longer.

Length of body	5·5 inches.
Width of ditto behind the transverse process . .	3·3 ,,

The two articulating costal surfaces are seen. Nothing shown as to the course of the vertebral foramen. From Moginund deposit.

No. 596. *Camelus Sivalensis.*—Lower jaw, fragment of right side, containing three well-worn molars *in situ*, a good deal covered with matrix. Horizontal ramus broken off on a line with the teeth in front and behind. From Sewalik hills.

No. 624. *Camelus (?)*—Upper end of right metacarpal with a wide articulating head suddenly contracting into the shaft. Section of shaft nearly triangular. From Moginund deposit.

No. 755. *Camelus Sivalensis.*—Fragment of lower jaw, right side, containing a single molar; this being the only specimen, besides No. 596 in the collection. From Moginund clay.

XII. SIVATHERIUM GIGANTEUM.

A New Fossil Ruminant Genus, from the Valley of Murkunda, in the Sewalik Branch of the Sub-Himalayan Mountains.[1]

BY HUGH FALCONER, M.D., AND CAPTAIN P. T. CAUTLEY.

The fossil which we are about to describe forms a new accession to extinct zoology. This circumstance alone would give much interest to it. But, in addition, the large size surpassing the rhinoceros, the family of mammalia to which it belongs, and the forms of structure which it exhibits, render the *Sivatherium* one of the most remarkable of the past tenants of the globe that have hitherto been detected in the more recent strata.

Of the numerous fossil mammiferous genera discovered and established by Cuvier, all were confined to the Pachydermata. The species belonging to other families have all their living representatives on the earth. Among the ruminantia, no remarkable deviation from existing types has hitherto been discovered, the fossil being closely allied to living species. The isolated position, however, of the giraffe and the *Camelidæ* made it probable that certain genera have become extinct which formed the connecting links between them and the other genera of the family, and further between the Ruminantia and the Pachydermata. In the Sivatherium[2] we have a ruminant of this description connecting

[1] This memoir is reprinted from the 'Asiatic Researches,' vol. xix. p. 1. 1836. Different views of the cranium of the Sivatherium are given in the two last published plates of the 'Fauna Antiqua Sivalensis' (xci. and xcii). Four other plates, not published, illustrate the remaining parts of the skeleton. The bones of the cranium, including the lower jaw, are also figured by Royle in his 'Illustrations of the Botany of the Himalayahs,' vol. ii. Plate vi.—[Ed.]

[2] We have named the fossil *Sivatherium*, from Siva, the Hindoo god, and θηρίον, *bellua*. The *Sewalik* or Sub-Himalayan range of hills is considered in the Hindoo mythology as the *Lutiah* or edge of the roof of Siva's dwelling in the *Himalayah*, and hence they are called the *Siva-ala*, or *Sib-ala*, which by an easy transition of sound became the *Sewalik* of the English. The fossil has been discovered in a tract which may be included in the *Sewalik* range, and we have given the name of Sivatherium to it, to commemorate this remarkable formation so rich in new animals. Another derivation of the name of the hills, as ex-

the family with the Pachydermata, and at the same time so marked by individual peculiarities as to be without an analogue in its order.

The fossil remain of the Sivatherium, from which our description is taken, is a remarkably perfect head. When discovered it was fortunately so completely enveloped by a mass of stone, that although it had long been exposed to be acted upon as a boulder in a water-course, all the more important parts of structure had been preserved. The block might have been passed over, but for an edging of the teeth in relief from it, which gave promise of something additional concealed. After much labour, the hard crystalline covering of stone was so successfully removed that the huge head now stands out with a couple of horns between the orbits, broken only near their tips, and the nasal bones projected in a free arch, high above the chaffron. All the molars on both sides of the jaw are present and singularly perfect. The only mutilation is at the vertex of the cranium, where the plain of the occipital meets that of the brow, and at the muzzle, which is truncated a little way in front of the first molar. The only parts which are still concealed are a portion of the occipital, the zygomatic fossæ on both sides, and the base of the cranium over the sphenoid bone.

The form of the head is so singular and grotesque that the first glance at it strikes one with surprise. The prominent features are:—first, the great size approaching that of the elephant; second, the immense development and width of the cranium behind the orbits; third, the two divergent osseous cores for horns starting out from the brow between the orbits; fourth, the form and direction of the nasal bones, rising with great prominence out of the chaffron, and overhanging the external nostrils in a pointed arch; fifth, the great massiveness, width, and shortness of the face forward from the orbits; sixth, the great angle at which the grinding plane of the molars deviates upwards from that of the base of the skull.

Viewed in profile, the form and direction of the horns and

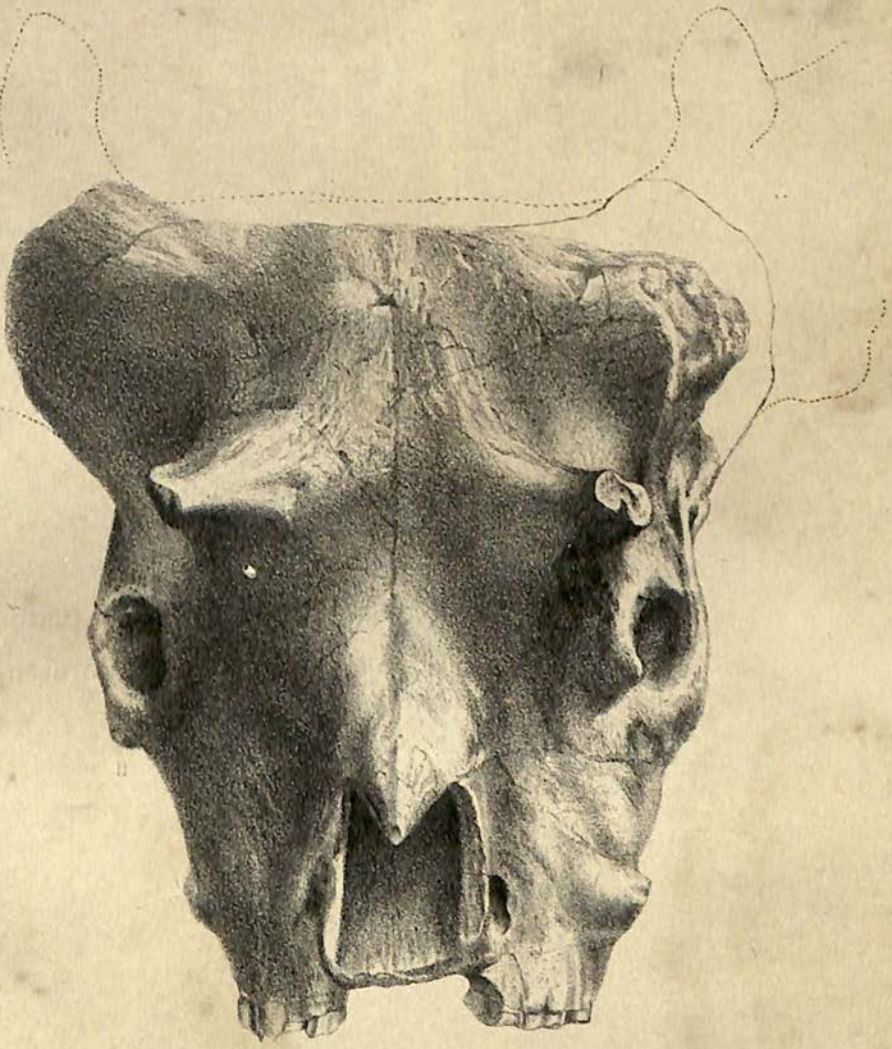
plained by the *Mahant*, or high priest at *Deyra*, is as follows:—

Sewalik, a corruption of *Siva-wala*, a name given to the tract of mountains between the Jumna and Ganges, from having been the residence of Iswara Siva and his son Ganes, who, under the form of an elephant, had charge of the westerly portion from the village of *Dudhli* to the Jumna, which portion is also called *Gangaja*, *gaja* being, in Hindoo, an elephant. That portion eastward from *Dudhli*, or between that village and *Hurdwar*, is called *Deodhar*, from its being the especial residence of *Deota*, or Iswara Siva; the whole tract however between the Jumna and Ganges is called *Siva-ala*, or the habitation of Siva: unde der. Sewalik.

DESCRIPTION OF PLATE XIX.

SIVATHERIUM GIGANTEUM.

Cranium of *Sivatherium giganteum*; one-sixth of the natural size; copied from the drawing, by Mr. Ford, in Plate XCI. of the Fauna Antiqua Sivalensis. In the British Museum. (See pages 249 & 537.)



G.H.Ford del. J.Dinkel lith.

W.West imp.

Sivatherium giganteum.

the rise and sweep in the bones of the nose give a character to the head widely differing from that of any other animal. The nose looks something like that of the rhinoceros, but the resemblance is deceptive, and only owing to the muzzle being truncated. Seen from the front, the head is somewhat wedge-shaped, the greatest width being at the vertex, and thence gradually compressed towards the muzzle, with contraction only at two points behind the orbits and under the malars. The zygomatic arches are almost concealed and nowise prominent; the brow is broad and flat, and swelling latterly into two convexities; the orbits are wide apart, and have the appearance of being thrown far forward, from the great production of the frontal upwards. There are no crests or ridges; the surface of the cranium is smooth, the lines are in curves, with no angularity. From the vertex to the root of the nose the plane of the brow is in a straight line with a slight rise between the horns. The accompanying drawings will at once give a better idea of the form than any description. (Plates XIX. and XX.)

Now, in detail of individual parts, and to commence with the most important and characteristic, the teeth:—

There are six molars on either side of the upper jaw. The third of the series, or last milk molar, has given place to the corresponding permanent tooth, the detrition of which and of the last molar is well advanced, and indicates the animal to have been more than adult.

The teeth are in every respect those of a ruminant, with some slight individual peculiarities (See Plate XX. fig. 1).

The three posterior or double molars are composed of two portions or semi-cylinders, each of which encloses, when partially worn down, a double crescent of enamel, the convexity of which is turned inwards. The last molar, as is normal in ruminants, has no additional complication, like that in the corresponding tooth of the lower jaw. The plane of grinding slopes from the outer margin inwards. The general form is exactly that of an ox or camel, on a large scale. The ridges of enamel are unequally in relief, and the hollows between them unequally scooped. Each semi-cylinder has its outer surface in horizontal section, formed of three salient knuckles, with two intermediate sinuses; and its inner surface, of a simple arch or curve. But there are certain peculiarities by which the teeth differ from those of other ruminants.

In correspondence with the shortness of jaw, the width of the teeth is much greater in proportion to the length than is usual in the family: the width of the third and fourth molars being to the length as 2·24 and 2·2 to 1·55 and 1·68 inches, respectively;

and the average width of the whole series being to the length as 2·13 to 1·76 inches. Their form is less prismatic; the base of the shaft swelling out into a bulge or collar, from which the inner surface slopes outward as it rises, so that the coronal becomes somewhat contracted; in the third molar the width at the coronal is 1·93, at the bulge of the shaft 2·24. The ridges and hollows on the outer surface descend less upon the shaft, and disappear upon the bulge. There are no accessory pillars on the furrow of junction at the inner side. The crescentic plates of enamel have a character which distinguishes them from all known ruminants; the inner crescent, instead of sweeping in a nearly simple curve, runs zig-zag-wise in large sinuous flexures, somewhat resembling the form in Elasmotherium.

The three double molars differ from each other only in their relative states of wearing. The antepenultimate being most worn, has the crescentic plates less curved, more approximate, and less distinct; the penultimate and last molars are less worn, and have the markings more distinct.

The three anterior or simple molars have the usual form which holds in Ruminantia, a single semi-cylinder with but one pair of crescents. The first one is much worn and partly mutilated; the second is more entire, having been a shorter time in use, and finely exhibits the flexuous curves in the sweep of the enamel of the inner crescent; the last one has the simple form of the permanent tooth which replaces the last milk molar, it also shows the wavy form of the enamel.

Regarding the position of the teeth in the jaw, the last four molars, viz. the three permanent and the last of replacement, run in a straight line, and on the opposite sides are parallel and equi-distant; the two anterior ones are suddenly directed inwards, so as to be a good deal approximated. If the two first molars were not thus inflected, the opposite lines of teeth would form exactly two sides of a square, the length of the line of teeth and the intervals between the outer surfaces of the four last molars being almost equal, viz. 9·8 and 9·9 inches respectively.

The plane of detrition of the whole series of molars from rear to front is not horizontal, but in a slight curve, and directed upwards at a considerable angle with the base of the skull, so that when the head is placed so as to rest upon the occipital condyles and the last molars, a plane through these points is cut by a chord along the curve of detrition of the whole series of molars at an angle of about 45 degrees. This is one of the marked characters about the head.

DESCRIPTION OF PLATE XX.

SIVATHERIUM GIGANTEUM.

Two other views of the cranium of *Sivatherium giganteum*, represented in Plate XIX.; one-sixth of the natural size. Fig. 1 shows the palate with the molar series on either side; fig. 2 shows well the offsets of the anterior and posterior horns. (See pages 249 & 537.)

Fig. 1.

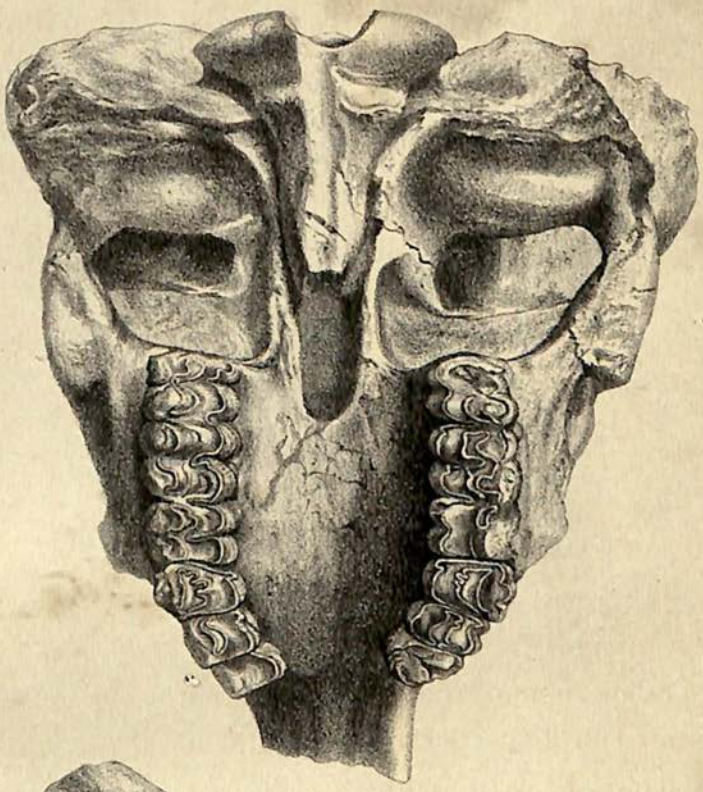
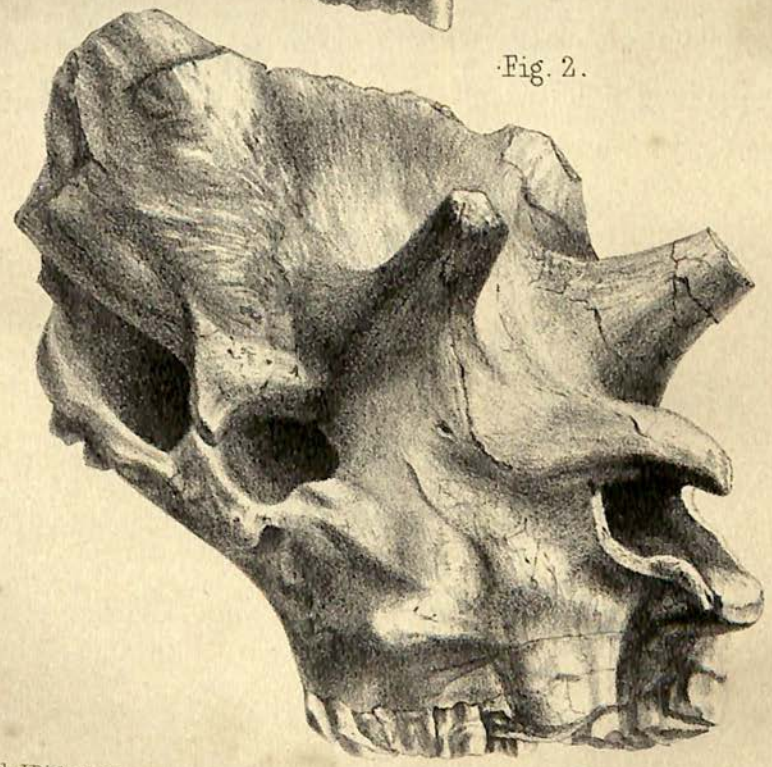


Fig. 2.



G.H.Ford del. J.Dinkel lith.

W.West imp

Sivatherium giganteum.

Dimensions of the Teeth.

	Length	Breadth
	Inches	Inches
Last molar right side	—	2·35
Penultimate ditto	2·20	2·38
Antepenultimate ditto.	1·68	2·20
Last simple molar	1·55	2·24
Second ditto	1·70	1·95
First ditto	1·70	1·90

	Outer surfaces	Inner surfaces
Interval between the surfaces of last molar	9·9	5·5
Ditto ditto ditto third molar	9·8	5·5
Ditto ditto ditto second molar	8·4	4·5
Ditto ditto ditto first molar	6·4	3·2

Space occupied by the line of molars, 9·8 inches.

Bones of the Head and Face.—From the age of the animal to which the head had belonged, the bones had become anchylosed at their commissures, so that every trace of suture has disappeared, and their limits and connections are not distinguishable.

The frontal is broad and flat, and slightly concave at its upper half. It expands laterally into two considerable swellings at the vertex, and sweeps down to join the temporals in an ample curve, and with no angularity. It becomes narrower forwards to behind the orbits, and then expands again in sending off an apophysis to join with the malar bone and complete the posterior circuit of the orbit. The width of the bone where narrowest, behind the orbit, is very great, being 16·2 inches. Partly between and partly to the rear of the orbits there arise, by a broad base passing insensibly into the frontal, two short thick conical processes. They taper rapidly to a point, a little way below which they are mutilated in the fossil. They start so erect from the brow that their axis is perpendicular to their basement, and they diverge at a considerable angle. From their base upwards they are free from any rugosities, their surface being smooth and even. They are evidently the osseous cores of two infra-orbital horns (Plate XIX. and Plate XX. fig. 2). From their position and size they form one of the most remarkable features in the head. The connections of the frontal are nowhere distinguishable, no mark of a suture remaining. At the upper end of the bone the skull is fractured and the structure of the bone is exposed. The internal and outer plates are seen to

be widely separated, and the interval to be occupied by large cells, formed by an expansion of the diploe into plates, as in the elephant. The interval exceeds 2½ inches in the occipital. On the left side of the frontal, the swelling at the vertex has its upper lamina of bone removed, and the cast of the cells exhibits a surface of almond-shaped or oblong eminences with smooth hollows between.

The temporal is greatly concealed by a quantity of the stony matrix, which has not been removed from the temporal fossa. No trace of the squamous suture remains to mark its limits and connection with the frontal. The inferior processes of the bone about the auditory foramen have been destroyed or are concealed by stone. The zygomatic process is long and runs forward to join the corresponding apophysis of the jugal bone, with little prominence or convexity. A line produced along it would pass in front, through the tuberosities of the maxillaries, and to the rear along the upper margin of the occipital condyles. The process is stout and thick. The temporal fossa is very long and rather shallow. It does not rise up high on the side of the cranium; it is over-arched by the cylinder-like sides of the frontal bone. The position and form of the articulating surface with the lower jaw are concealed by stone, which has not been removed.

There is nothing in the fossil to enable us to determine the form and limits of the parietal bones: the cranium being chiefly mutilated in the region which they occupy. But they appear to have had the same form and character as in the ox; to have been intimately united with the occipitals, and to have joined with the frontal at the upper angle of the skull.

The form and characters of the occipital are very marked. It occupies a large space, having width proportioned to that of the frontal, and considerable height. It is expanded laterally into two alæ, which commence at the upper margin of the foramen magnum and proceed upwards and outwards. These alæ are smooth, and are hollowed out downwards and outwards from near the condyles towards the mastoid region of the temporal. Their inner or axine margins proceed in a ridge arising from the border of the occipital foramen, diverging from each other nearly at right angles, and enclose a large triangular fossa, into which they descend abruptly. This fossa is chiefly occupied by stone in the fossil, but it does not appear shallow, and seems a modification of the same structure as in the elephant. There is no appearance of an occipital crest or protuberance. The bone is mutilated at the sides towards the junction with the temporals. Both here and at its upper fractured margin its structure is seen

to be formed of large cells, with the diploe expanded into plates, and the outer and inner laminæ wide apart. This character is very marked at its upper margin, where its cells appear to join on with those of the frontal. The condyles are very large and fortunately very perfect in the fossil (Plate XX. fig. 1); the longest diameter of each is 4·4 inches, and the distance measured across the foramen magnum from their outer angles is 7·4 inches—dimensions exceeding those of the elephant. Their form is exactly as in the Ruminantia, viz. their outer surface composed of two convexities meeting at a rounded angle: one in the line of the long axis, stretching obliquely backwards from the anterior border of the foramen magnum; the other forwards and upwards from the posterior margin, their line of commissure being in the direction of the transverse diameter of the foramen. The latter is also of large size, its antero-posterior diameter being 2·3 inches and the transverse diameter 2·6 inches. The large dimensions of the foramen and condyles must entail a corresponding development in the vertebræ, and modify the form of the neck and anterior extremities.

The sphenoidal bone, and all the parts along the base of the skull, from the occipital foramen to the palate, are either removed or so concealed by stone as to give no characters for description.

The part of the brow from which the nasal bones commence is not distinguishable. The suture connecting them with the frontal is completely obliterated, and it is not seen whether they run up into a sinus in that bone or how they join on with it. Between the horns there is a rise in the brow, which sinks again a little forward. A short way in advance of a line connecting the anterior angles of the orbits there is another rise in the brow. From this point, which may be considered their base, the nasal bones commence ascending from the plane of the brow at a considerable angle. They are broad and well arched at their base and proceed forward with a convex outline, getting rapidly narrower, to terminate in a point curved downwards, which overhangs the external nostrils. For a considerable part of their length they are joined to the maxillaries; but forwards from the point where they commence narrowing, their lower edge is free and separated from the maxillaries by a wide sinus, so that viewed in lateral profile their form very much resembles the upper mandible of a hawk, detached from the lower. Unluckily in the fossil, the anterior margins of the maxillaries are mutilated, so that the exact length of the nasal bone that was free from connection with them cannot be determined. As the fossil stands, about four inches of the lower edge of the nasals, measured along the curve, are free.

The same mutilation prevents its being seen how near the incisives approached the nasals, with which they do not appear to have been joined. This point is one of great importance, from the structure it implies in the soft parts about the nose. The height and form of the nasal bones are the most remarkable feature in the head; viewed from above they are seen to taper rapidly from a broad base to a sharp point, and the vertical height of their most convex part above the brow at their base is $3\frac{1}{2}$ inches.

The form of the maxillaries is strongly marked in two respects: first, in their shortness compared with their great width and depth; second, in the upward direction of the line of alveoli from the last molar forwards, giving the appearance (with the licence of language intended to convey an idea of resemblance without implying more) as if the face had been pushed upwards to correspond with the rise in the nasals, or fixed on at an angle with the base of the cranium. The tendency to shortness of the jaw was observed in the dimensions of the teeth, the molars being compressed and their width exceeding their length to an extent not usual in the Ruminantia. The width apart between the maxillaries was noticed before, the interval between the outer surfaces of the alveoli equalling the space in length occupied by the line of molars. The cheek tuberosities are very large and prominent, their diameter at the base being 2 inches, and the width of the jaw over them being 12·2 inches, whereas at the alveoli it is but 9·8 inches. They are situated over the third and fourth molars; and proceeding up from them towards the malar there is an indistinct ridge on the bone. The infra-orbital foramen is of large size, its vertical diameter being 1·2 inch; it is placed over the first molar as in the ox and deer tribe. The muzzle portion of the bone is broken off at about 2·8 inches from the first molar, from the alveolar margin of which to the surface of the diastema there is an abrupt sink of 1·7 inch. The muzzle is here contracted to 5·8 inches, and forwards at the truncated part to about 4·1. The palatine arch is convex from rear to front, and concave across. No trace of the palatine foramina remains, nor of the suture with the proper palatine bones. The spheno-palatine apophyses and all back to the foramen magnum[1] are either removed or concealed in stone. In front, the mutilation of the bone, at the muzzle, does not allow to be seen how the incisive bones were connected with the maxillaries; but it appears that they did not reach so high on the maxillaries as the

[1] With the exception of a portion of the basilary region, which resembles that of the Ruminants.

union of the latter with the nasals. The same cause has rendered obscure the connections of the maxillaries with the nasals and the depth and size of the nasal echancrure or sinus.

The jugal bone is deep, massive, and rather prominent. Its lower border falls off abruptly in a hollow descending on the maxillaries; the upper enters largely into the formation of the orbit. The posterior orbital process unites with a corresponding apophysis of the frontal, to complete the circuit of the orbit behind. The zygomatic apophysis is stout and thick, and rather flat. No part of the arch, either in the temporal or jugal portions, is prominent; the interval between the most salient points being greatly less than the hind part of the cranium, and slightly less than the width between the bodies of the jugals.

The extent and form of the lachrymals cannot be made out, as there is no trace of a suture remaining. Upon the fossil, the surface of the lachrymal region passes smoothly into that of the adjoining bones. There is no perforation of the lower and anterior margin of the orbit by lachrymal foramina, nor any hollow below it indicating an infra-orbital or lachrymal sinus. It may be also added, what was omitted before, that there is no trace of a superciliary foramen upon the frontal.

The orbits are placed far forwards, in consequence of the great production of the cranium upwards and the shortness of the bones of the face. Their position is also rather low, their centre being about 3·6 inches below the plane of the brow. From a little injury done in chiselling off the stone, the form in circle of the different orbits does not exactly correspond. In the one of the left side, which is the more perfect, the long axis makes a small angle with that of the plane of the brow. The antero-posterior diameter is 3·3 inches, and the vertical 2·7 inches. There is no prominence or inequality in the rim of the orbits, as in the Ruminantia. The plane of the rim is very oblique; the interval between the upper or frontal margins of the two orbits being 12·2 inches, and that of the lower or molar margin 16·2 inches.

Dimensions of the Skull of the Sivatherium giganteum.[1]

	Eng. Inches	Mètres
From the anterior margin of the foramen magnum to the alveolus of first molar	18·85	·478
From ditto to the truncated extremity of the muzzle	20·6	·5268
From ditto to the posterior margin of the last molar	10·3	·262
From the tip of the nasals to the upper fractured margin of the cranium	18·0	·4568
From ditto ditto to ditto along the curve	19·0	·4822
From ditto ditto along the curve to where the nasal arch begins to rise from the brow	7·8	·198
From the latter point to the fractured margin of the cranium	11·2	·284
From the tip of the nasals to a chord across the tips of the horns	8·5	·216
From the anterior angle, right orbit, to the first molar	9·9	·251
From the posterior ditto ditto to the fractured margin of the cranium	12·1	·3075
Width of cranium at the vertex (mutilation at left side restored) about	22·0	·559
Ditto between the orbits, upper borders	12·2	·3095
Ditto ditto, lower borders	16·2	·4108
Ditto behind the orbits at the contraction of the frontal	14·6	·3705
Ditto between the middle of the zygomatic arches	16·4	·4168
Width between the bodies of the malar bones	16·62	·422
Ditto base of the skull behind the mastoid processes (mutilated on both sides)	19·5	·496
Ditto between the cheek tuberosities of the maxillaries	12·2	·3095
Ditto of muzzle portion of the maxillaries in front of the first molar	5·8	·149
Ditto of ditto where truncated (partly restored)	4·1	·104
Ditto between the outer surfaces of the horns at their base	12·5	·312
Ditto ditto ditto fractured tips of ditto	13·65	·347
Perpendicular from a chord across tips of ditto to the brow	4·2	·165
Depth from the convexity of the occipital condyles to middle of frontal behind the horns	11·9	·302
Ditto from the body of the sphenoidal to ditto between the horns	9·94	·252
Ditto from middle of the palate between the third and fourth molars to ditto at root of the nasals	7·52	·192
Ditto from posterior surface, last molar, to extremity of the nasals	13·0	·331
Ditto from grinding surface penultimate molar to root of the nasals	10·3	·262
Ditto from the convexity near the tip of the nasals to the palatine surface in front of the first molar	5·53	·14
Depth from middle of the ala of the occipital to the swell at vertex of frontal	8·98	·228
Ditto from inferior margin of the orbit to grinding surface 5th molar	7·3	·186
Ditto from the grinding surface, 1st molar, to edge of the palate in front of it	2·6	·066
Space from the anterior angle of orbit to tip of the nasals	10·2	·2595
Antero-posterior diameter left orbit	3·3	·084
Vertical ditto ditto	2·7	·0685
Antero-posterior diameter of the foramen magnum	2·3	·058
Transverse ditto ditto	2·6	·066
Long diameter of each condyle	4·4	·112
Short or transverse ditto of ditto	2·4	·0603
Interval between the external angles of ditto measured across the foramen	7·4	·188

[1] To facilitate comparison with the large animals described in Cuvier's 'Ossemens Fossiles,' the dimensions are also given in French measure.

Among a quantity of bones collected in the neighbourhood of the spot in which the skull was found there is a fragment of the lower jaw of a very large ruminant, which we have no doubt belonged to the Sivatherium; and it is even not improbable that it came from the same individual with the head described. It consists of the hind portion of the right jaw, broken off at the anterior third of the last molar. The coronoid apophysis, the condyle, with the corresponding part of the ramus, and a portion of the angle, are also removed. The two posterior thirds only of the last molar remain; the grinding surface is partly mutilated, but is sufficiently distinct to show the crescentic plates of enamel and proves that the tooth belonged to a ruminant. The outline of the jaw in vertical section is a compressed ellipse, and the outer surface is more convex than the inner. The bone thins off, on the inner side towards the angle of the jaw, into a large and well-marked muscular hollow; and running up from the latter, upon the ramus towards the foramen of the artery, there is a well defined furrow, as in the Ruminantia. The surface of the tooth is covered with very small rugosities and striæ, as in the upper molars of the head. It had been composed of three semi-cylinders, as is normal in the family, and the advanced state of its wearing proves the animal from which it proceeded to have been more than adult.

The form and relative proportions of the jaw agree very closely with those of the corresponding parts of a Buffalo. The dimensions compared with those of the Buffalo and Camel are thus:—

	Sivatherium	Buffalo	Camel
	Inches	Inches	Inches
Depth of the jaw from the alveolus of last molar	4·95	2·65	2·70
Greatest thickness of ditto	2·3	1·05	1·4
Width of middle of last molar	1·35	0·64	0·76
Length of posterior 2nd and 3rd of ditto	2·15	0·95	1·15

No known ruminant, fossil or existing, has a jaw of such a large size; the average dimensions above given being more than double those of a Buffalo, which measured in length of head 19·2 inches (·489 mètres), and exceeding those of the corresponding parts of the Rhinoceros. We have, therefore, no hesitation in referring the fragment to the *Sivatherium giganteum*. (See Plate XXI. fig. 1.)

The above comprises all that we know regarding the osteology of the head from an actual examination of the

parts. We have not been so fortunate hitherto as to meet with any other remain, comprising the anterior part of the muzzle either of the upper or lower jaw.[1] We shall now proceed to deduce the form of the deficient parts, and the structure of the head generally, to the extent that may be legitimately inferred from the data of which we are in possession.

Notwithstanding the singularly perfect condition of the head, for an organic remain of such enormous size, we cannot but regret the mutilation at the muzzle and vertex, as it throws a doubt upon some very interesting points of structure in the Sivatherium: 1st, the presence or absence of incisive and canine teeth in the upper jaw, and their number and character if present; 2nd, the number and extent of the bones which enter into the basis of the external nostrils; and 3rd, the presence or absence of two horns on the vertex, besides the two infra-orbital ones.

Regarding the first point, we have nothing sufficient to guide us with certainty to a conclusion, as there are ruminants both with and without incisives and canines in the upper jaw; and the Sivatherium differs most materially in structure from both sections. But there are two conditions of analogy which render it probable that there were no incisives. First: in all ruminants which have the molars in a contiguous and normal series, and which have horns on the brow, there are no incisive teeth. In the Camel and its congeners, where the anterior molar is unsymmetrical and separated from the rest of the series by an interval, incisives are present in the upper jaw. The Sivatherium had horns, and its molars were in a contiguous series; it is therefore probable that it had no incisives. Regarding the canines there is no clue to a conjecture, as there are species in the same genus of ruminants both with and without them. Second: the extent and connections of the incisive bones are points of great interest, from the kind of development which they imply in the soft parts appended to them.

[1] In a note received from Captain Cautley, while this paper is in the press, that gentleman mentions the discovery of a portion of the skeleton of a Sivatherium in another part of the hills: see Journal As. Soc., vol. iv. 'During my recent trip to the Sewaliks near the Pinjore valley, the field of Messrs. Baker and Durand's labours, I regretted much my inability to obtain the dimensions of one of the most superb fossils I suppose that ever was found. It was unfortunately discovered and excavated by a party of workpeople employed by a gentleman with whom I was unacquainted, and although I saw the fossil when in the rock, I was prevented from getting the measurements afterwards. This specimen consisted of the femur and tibia, with the tarsal, metatarsal, and phalanges of our Sivatherium.' It is much to be regretted that such an opportunity should have been lost of adding to the information already acquired of this new and gigantic Ruminant.—[J. PRINSEP, SEC. As. Soc.]

In most of the horned ruminantia, the incisives run up by a narrow apophysis along the anterior margins of the maxillary bones, and join on to a portion of the sides of the nasals; so that the bony basis of the external nostrils is formed of but two pairs of bones, the nasals and the incisives. In the Camel, the apophyses of the incisives terminate upon the maxillaries without reaching the nasals, and there are three pairs of bones to the external nostrils: the nasals, maxillaries, and incisives. But neither in the horned ruminants, nor in the Camel and its congeners, do the bones of the nose rise out of the plane of the brow with any remarkable degree of saliency, nor are their lower margins free to any great extent towards the apex. They are long slips of bone, with nearly parallel edges, running between the upper borders of the maxillaries, and joined to the ascending process of the incisive bone, near their extremity, or connected only with the maxillaries; but in neither case projecting so as to form any considerable re-entering angle, or sinus, with these bones.

In our fossil, the form and connections of the nasal bones are very different. Instead of running forward in the same plane with the brow, they rise from it at a rounded angle of about 130 degrees, an amount of saliency without example among ruminants, and exceeding what holds in the Rhinoceros, Tapir, and Palæotherium, the only herbivorous animals with this sort of structure. Instead of being in nearly parallel slips, they are broad and well arched at their base, and converge rapidly to a sharp tip which is hooked downwards, over-arching the external nostrils. Along a considerable portion of their length they are unconnected with the adjoining bones, their lower margins being free and so wide apart from the maxillaries as to leave a gap or sinus of considerable length and depth in the bony parietes of the nostrils. The exact extent to which they are free is unluckily not shown in the fossil, as the anterior margin of the maxillaries is mutilated on both sides, and the connection with the incisives destroyed. But as the nasal bones shoot forward beyond the mutilated edge of the maxillaries, this circumstance, together with their well-defined outline and symmetry on both sides of the fossil, and their rapid convergence to a point with some convexity, leaves not a doubt that they were free to a great extent, and unconnected with the incisives.

Now to determine the conditions of the fleshy parts, which the structure in the bony parietes of the nostrils entails.

The analogies are to be sought for in the Ruminantia and Pachydermata.

The remarkable saliency of the bones of the nose in the Sivatherium has no parallel, in known ruminants, to guide us; and the connection of the nasals with the incisives, or the reverse, does not imply any important difference in structure in the family. In the Bovine section, the Ox and the Buffalo have the nasals and incisives connected; whereas they are separate in the Yak,[1] and Aurochs. In the Camel they are also separate, and this animal has greater mobility in the upper lip than is found in other ruminants.

In the Pachydermata both these conditions of structure are present and wanting in different genera; and their presence or absence is accompanied with very important differences in the form of the corresponding soft parts. It is, therefore, in this family that we are to look for an explanation of what is found in the Sivatherium.

In the Elephant and Mastodon, the Tapir, Rhinoceros, and Palæotherium, there are three pairs of bones to the external nostrils, viz.: the nasals, the maxillaries, and incisives.[2] In all these animals the upper lip is highly developed, so as to be prehensile as in the Rhinoceros, or extended into a trunk as in the Elephant and Tapir; the amount of development being accompanied with corresponding difference in the position and form of the nasal bones. In the Rhinoceros they are long and thick, extending to the point of the muzzle, and of great strength to support the horns of the animal; and the upper lip is broad, thick and very mobile, but little elongated. In the Elephant they are very short, and the incisives enormously developed for the insertion of the tusks, and the trunk is of great length. In the Tapir they are short and free except at the base, and projected high above the maxillaries; and the structure is accompanied by a well-developed trunk. In the other Pachydermatous genera there are but two pairs of bones to the external nostrils, the nasals and incisives; the latter running up so as to join on with the former; and the nasals, instead of being short and salient, with a sinus laterally between them and the maxillaries, are long and run forward united to the maxillaries, more or less resembling the nearly parallel slips of the Ruminantia. Of these genera the horse has the upper lip endowed with considerable mobility; and the lower end of the nasals is at the same time free to a small extent. In all the other genera there is nothing resembling a prehensile organ in the upper lip.

In the Sivatherium the same kind of structure holds as is found in the Pachydermata with trunks. Of these it most

[1] Cuvier, Ossemens Fossiles, tome iv. p. 131.

[2] Cuvier, Ossemens Fossiles, tome iii. p. 29.

nearly resembles the Tapir. It differs chiefly in the bones of the nose being larger and more salient from the chaffron, and in there being less width and depth to the naso-maxillary sinus than the Tapir exhibits. But as the essential points of structure are alike in both, there is no doubt that the Sivatherium was invested with a trunk like the Tapir.

This conclusion is further borne out by other analogies, although more indirect than that afforded by the nasal bones.

1st.—The large size of the infra-orbital foramen. In the fossil the exact dimensions are indistinct, from the margin having been injured in the chiselling off of the matrix of stone; the vertical diameter we make out to be 1·2 inch, which, perhaps, may be somewhat greater than the truth, but anything approaching this size would indicate a large nerve for transmission, and a highly developed condition of the upper lip.

2nd.—The external plate of the bones of the cranium is widely separated from the inner, by an expansion of the diploe into vertical plates, forming large cells, as in the cranium of the Elephant, and the occipital is expanded laterally into alæ, with a considerable hollow between, as in the Elephant. Both these conditions are modifications of structure, adapted for supplying an extensive surface for muscular attachment, and imply a thick fleshy neck, with limited range of motion; and, in more remote sequence, go to prove the necessity of a trunk.

3rd.—The very large size of the occipital condyles, which are greater, both in proportion and in actual measurement, than those of the Elephant, the interval between their outer angles, taken across the occipital foramen, being 7·4 inches. The atlas and the rest of the series of cervical vertebræ must have been of proportionate diameter to receive and sustain the condyles, and surrounded by a large mass of flesh. Both these circumstances would tend greatly to limit the range of motion of the head and neck. But to suit the herbivorous habits of the animal, it must have had some other mode of reaching its food, or the vertebræ must have been elongated in a ratio to their diameter, sufficient to admit of free motion to the neck. In the latter case the neck must have been of great length, and to support it and the load of muscles about it, an immense development would be required in the spinal apophysis of the dorsal vertebræ, and in the whole anterior extremity, with an unwieldy form of the body generally. It is, therefore, more probable that the vertebræ were condensed as in the Elephant, and the neck short and thick, admitting of limited motion to the head, circumstances indirectly corroborating the existence of a trunk.

4th.—The face is short, broad, and massive, to an extent

not found in the Ruminantia, but somewhat resembling that of the Elephant, and suitable for the attachment of a trunk.

Next with regard to the horns:—

There can be no doubt that the two thick short and conical processes between the orbits were the cores of horns, resembling those of the Bovine and Antelopine sections of the Ruminantia. They are smooth, and run evenly into the brow without any burr. The horny sheaths which they bore must have been straight, thick, and not much elongated. None of the bicorned Ruminantia have horns placed in the same way, exactly between and over the orbits; they have them more or less to the rear. The only ruminant which has horns similar in position is the four-horned Antelope[1] of Hindostan, which differs only in having its anterior pair of horns a little more in advance of the orbits than occurs in the Sivatherium. The correspondence of the two at once suggests the question, 'Had the Sivatherium also two additional horns on the vertex?' The cranium in the fossil is mutilated across at the vertex, so as to deprive us of direct evidence on the point, but the following reasons render the supposition at least probable:—

1st.—As above stated in the bi-cavicorned Ruminantia, the osseous cores are placed more or less to the rear of the orbits.

2nd.—In such known species as have four horns, the supplementary pair is between the orbits, and the normal pair well back upon the frontal.

3rd.—In the Bovine section of Ruminantia the frontal is contracted behind the orbits, and upwards from the contraction it is expanded again into two swellings at the lateral angles of the vertex, which run into the bases of the osseous cores of the horns. This conformation does not exist in such of the Ruminantia as want horns or as have them approximated on the brow. It is present in the Sivatherium.

On either supposition the infra-orbital horns are a remarkable feature in the fossil, and if they were a solitary pair on the head, the structure, from their position, would perhaps be more singular than if there had been two additional horns behind.[2]

Now to estimate the length of the deficient portion of the muzzle, and the entire length of the head:—

In most of the Ruminantia, where the molars are in a contiguous uninterrupted series the interval from the first molar to the anterior border of the incisive bones is nearly equal to the space occupied by the molars, in some greater, in some a little less, and generally the latter. In other Ruminantia, such as the *Camelidæ*, where the anterior molars are unsym-

[1] The *Tetracerus* or *Antilope quadricornis* and *Chikarra* of authors.

[2] See Appendix, No. I. and Plate xxi. —[Ed.]

metrical with the others, and separated from them by being placed in the middle of the diasteme, this ratio does not hold, the space from the first molar to the margin of the incisives being less than the line of molars. In the Sivatherium the molars are in a contiguous series, and if on this analogy we deduce the length of the muzzle we get nearly ten inches for the space from the first molar to the point of the incisives, and 28·85 inches for the whole length of the head from the border of the occipital foramen to the margin of the incisives; these dimensions may be a little excessive, but we believe them not to be far out, as the muzzle would still be short for the width of the face in a ruminant.

The orbits next come to be considered. The size and position of the eye form a distinguishing feature between the Ruminantia and the Pachydermata. In the former it is large and full, in the latter smaller and sunken, and the expression of the face is more heavy in consequence. In the Sivatherium the orbit is considerably smaller in proportion to the size of the head than in existing ruminants. It is also placed more forward in the face, and lower under the level of the brow. The rim is not raised and prominent as in the Ruminantia and the plane of it is oblique, the interval between the orbits at their upper margin being 12·2 inches, and at the lower 16·2 inches. The longitudinal diameter exceeds the vertical in the ratio of five to four nearly, the long axis being nearly in a line from the naso-maxillary sinus across the limb of the zygomatic arch. From the above we infer that the eye was smaller and less prominent than in existing ruminants; and that the expression of the face was heavier and more ignoble, although less so than in the Pachydermata, excepting the horse; also that the direction of vision was considerably forwards as well as lateral, and that it was cut off towards the rear.

This closes what we have been led to infer regarding the organs of the head. With respect to the rest of the skeleton we have nothing to offer, as we are not at present possessed of any other remains which we can with certainty refer to the Sivatherium.[1] Among a quantity of bones[2] collected from the same neighbourhood with the fossil head, there are three singularly perfect specimens of the lower portions of the extremities of a large ruminant, belonging to three legs

[1] See Appendix, Nos. II. and III.—[Ed.]

[2] We note here a very perfect cervical vertebra of a ruminant in our possession, which must have belonged to an animal of proportions equal to that of the Sivatherium; but from certain characters we are inclined to suspect that it is allied to some other gigantic species of Ruminant, of the existence of which we have already a tolerable certainty. Of the existence of the Elk, and a species of *Camelidæ*, Lieut. Baker, of the Engineers, has shown us ample proof.

of one individual. They greatly exceed the size of any known ruminant, and, excepting the *Sivatherium giganteum*, there is no other ascertained animal of the order in our collection, of proportionate size to them. We forbear from further noticing them at present, as they appear small in comparison for our fossil; and, besides, there are indications in our collection, in teeth and other remains, of other large ruminants different from the one we have described.

The forms of the vertebræ, and more especially of the carpi and tarsi, are points of great interest to be ascertained; as we may expect modifications of the usual type adapted to the large size of the animal. From its bulk and armed head, few animals could be strong enough to contend with it, and we may expect that its extremities were constructed more to give support than for rapidity of motion. But, in the rich harvest which we still hope to reap in the valleys of the Murkunda, it is probable that specimens to illustrate the greater part of the osteology of the Sivatherium will at no very distant period be found.

The structure of the teeth suggests an idea regarding the peculiarities of the herbivorous habits of the animal. In the description it was noticed that the inner central plate of enamel ran in a flexuous sweep, somewhat resembling what is seen in the Elasmotherium, an arrangement evidently intended to increase the grinding power of the teeth. It may hence be inferred that the food of the Sivatherium was less herbaceous than that of existing horned ruminants, and derived from leaves and twigs; or that, as in the horse, the food was more completely masticated, the digestive organs less complicated, the body less bulky, and the necessity of regurgitation from the stomach less marked than in the present Ruminantia.

The following dimensions, contrasted with those of the Elephant and Rhinoceros, will afford a tolerably accurate idea of the size of the Sivatherium. They are characteristic although not numerous:—

	Elephant	Sivatherium	Indian 1-horned Rhinoceros
	Inches	Inches	Inches
From margin of foramen magnum to the first molar	23·10	18·85	24·9
Greatest width of the cranium	26·0	22·0	12·05
Ditto ditto of face between the malar bones	18·5	16·62	9·20
Greatest depth of the skull	17·80	11·9	11·05
Long diameter of the foramen magnum	2·55	2·6	2·6
Short ditto ditto ditto	2·4	2·3	1·5
Average of the above	15·06	12·38	10·22

If the view which we have taken of the fossil be correct, the Sivatherium was a very remarkable animal, and it fills up an important blank in the interval between the Ruminantia and Pachydermata. That it was a ruminant, the teeth and horns most clearly establish; and the structure which we have inferred of the upper lip, the osteology of the face, and the size and position of the orbit, approximate it to the Pachydermata. The circumstance of anything approaching a proboscis is so abnormal for a ruminant, that at the first view it might raise a doubt regarding the correctness of the ordinal position assigned to the fossil; but when we inquire further, the difficulty ceases.

In the Pachydermata there are genera with a trunk, and others without a trace of it. This organ is, therefore, not essential to the constitution of the order, but accidental to the size of the head, or habits of the animal in certain genera. Thus, in the Elephant nature has given a short neck to support the huge head, the enormous tusks, and the large grinding apparatus of the animal; and by such an arrangement, the construction of the rest of the frame is saved from the disturbance which a long neck would have entailed. But as the lever of the head became shortened, some other method of reaching its food became necessary; and a trunk was appended to the mouth. We have only to apply analogous conditions to a ruminant, and a trunk is equally required. In fact, the Camel exhibits a rudimentary form of this organ, under different circumstances. The upper lip is cleft; each of the divisions is separately moveable and extensible, so as to be an excellent organ of touch.

The fossil was discovered near the Murkunda river, in one of the small valleys which stretch between the Kyarda-dun and the Valley of Pinjore in the Sewalik or Sub-Himalayan belt of hills, associated with bones of the fossil Elephant, Mastodon, Rhinoceros, Hippopotamus, &c. So far as our researches yet go, the Sivatherium was not numerous. Compared with the Mastodon and Hippopotamus (*H. Sivalensis*, Nobis, a new species characterized by having six incisors in either jaw) it was very rare.

NORTHERN DOAB: *September* 15, 1835.

APPENDIX.

I.—MS. Note by Dr. Falconer on a Specimen Discovered by Col. Colvin.[1]

In a preceding article, in describing the head of the *Sivatherium giganteum*, the mutilation of the cranium at the vertex was noticed as one of the deficiencies in the specimen from which the description was taken. Although, in consequence, deprived of direct evidence on the point, we were led to infer (p. 262), partly from analogy and partly from the form of the portion of the frontal over-arching the temporal fossa, that the Sivatherium had two horns at the back of the head, besides the two infra-orbital horns presented by the specimen—that the animal was, in short, a huge four-horned ruminant. A superb specimen lately discovered by Col. Colvin has put the matter at rest and entirely confirmed our inference. Besides, these rear horns, by their form, constitute one of the most remarkable characters about the fossil.

The fossil consists of the posterior half of the head broken obliquely off behind the orbits. The right anterior horn is present, the left one has been removed by the oblique direction of the fracture, which stretches back so as to include part of the base of the left rear horn. The bases or pedicles of both the back horns are present, and the right one to some extent. The occipital is almost entire, and its ridges and depressions are well marked, and the condyles entire.

The frontal, as in the bovine genera, runs back so as to meet the occipital plane, sloping only a little behind the rear horns. As in the Bovines, the parietals are not distinguishable from the occipitals with which they are anchylosed. The general plane of the occipital descends vertically as in the Bovines, from its intersection with the frontals. The condyles project obliquely outwards from the plane of the occipital more than in the *Bovidæ*, *Cervidæ*, or *Capridæ*. The occipital is much broader for its height than in any of these, the one dimension being nearly double that of the other. The middle of the plane of the bone is occupied by a deep hollow as described at page 252, triangular downwards. The occipital crest runs in a double arch, as in the *Antilope cervicapra*, the commissure of the arcs descending by a peak into the

[1] Now for the first time published.—[Ed.]

DESCRIPTION OF PLATE XXI.

SIVATHERIUM GIGANTEUM.

Fig. 1. Left side of lower jaw with four molars, about one-fifth of the natural size. Copied from a drawing in Royle's 'Illustrations of the Botany of the Himalayahs,' vol. ii., Plate VI., fig. 1 *d*. This specimen differs from that referred to at page 257, but it was described and figured by Colonel Colvin in the Journ. As. Soc., vol. vi. p. 152. The specimen was found near the sources of the Sombe river, north of Dadoopoor and east of Nahun, and is now in the British Museum. Cat. No. 40,667.

Fig. 2. This is the important specimen discovered by Col. Colvin, and now in the Museum of the University of Edinburgh, which proved the correctness of Dr. Falconer's inference as to the existence of a posterior pair of horns in *Sivatherium*. The specimen is drawn one-sixth of the natural size. A description of it by Dr. Falconer will be found at page 266. (See also pages 268 & 538.)

Fig. 3. Is a fragment from the middle of the posterior horn. It was originally in Sir Proby Cautley's collection, and is now in the British Museum. Cat. No. 39,525. It was found to correspond to the posterior horn-core of the specimen represented in fig. 2. The figure is one-sixth of the natural size, and is copied from a drawing, by Mr. Ford, in an unpublished Plate of the Fauna Antiqua Sivalensis. (See pages 268 & 539.)

Fig. 4. Restoration by Mr. Dinkel of the skull of *Sivatherium giganteum*, showing the anterior and posterior pairs of horns, one-eighteenth of the natural size.

Fig. 5. Fragment of sternum, about one-seventh of the natural size. The figure is copied from a drawing, by Mr. Dinkel, in an unpublished plate of the Fauna Antiqua Sivalensis. (See pages 270 & 540.)

Fig. 4.

Fig. 3.

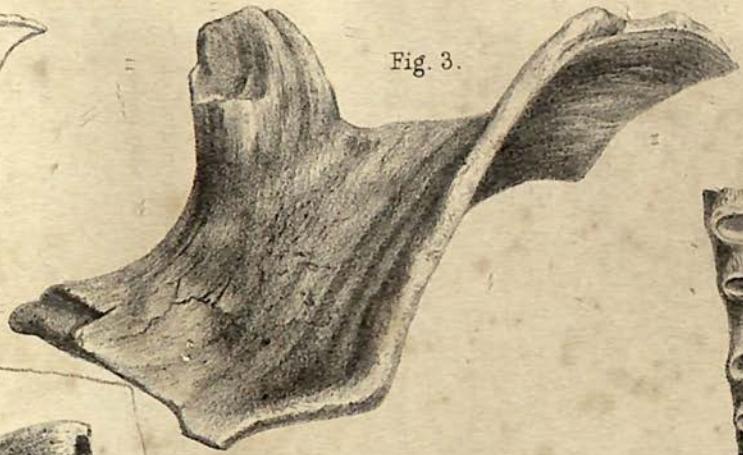


Fig. 5.

Fig. 2.

Fig. 1.

G.H. Ford del. J. Dinkel lith.

W. West imp.

Sivatherium giganteum.

hollow, and the suture, as in the *Bovidæ*, appears to have been lower than the crest.

The mastoid regions on both sides are of great width, equalling that of the space across the two condyles. The frontal, as before mentioned, is contracted between the rear and front horns, and is depressed slightly in the interval between them, from which it swells on either side in a bulge which runs into the base of the horns. The base of the left rear horn is only present in part. The right one shoots out laterally and backwards, and slightly upwards, as in the *Bovidæ*, and from the rear portion of the frontal, where it meets the plane of the occipital exactly as in the Bos. It overhangs the temporal fossa, and the fossa has the same form exactly as in the *Bovidæ*. The pedicle for the first 4½ inches of its rise from the swell of the brow is contracted; it then expands with a hollow and a flattish edge both posteriorly and anteriorly, its vertical diameter being 3·3 while its longitude is 5·68 at the contraction, but at the expansion it is 7¾. The horn now presents the extraordinary appearance of trifurcating, one main branch composing the greatest portion of the diameter of the horn, being given out from the centre and proceeding laterally and upwards. It has a central hollow core of about 2 inches diameter and walls of about an inch in thickness. The posterior branch, which is broken off at its base, is sent off at right angles to the central one, and nearly in the same plane. It has no hollow core, but is cancellated throughout, like the articulating heads of the bones of the extremities. It appears to have proceeded directly backwards, and to have been much smaller than the central one. The hollow core of the central branch is incomplete at its outer and lower side, having no cincture of bone here, but joins on with an oblong production of hollow proceeding downwards and outwards. This lower branch at its anterior and lower side is surrounded by a cancellated paries of bone, which is sharp and flattened forwards and nearly two inches in thickness. This appears to have been the centre of a third branch or off-set from the common pedicle proceeding directly outwards. The anterior or front horn is broken off close to the base, which is hollow, and with an appearance of large cells from the parietes of it.

Now what was the character of the horns? Were they cores of hollow horns as in the *Bovidæ?*—or branched antlers as in the *Cervidæ?*—or were the front the former, and the rear the latter? About the front ones there can be no doubt. They are conical, rise rapidly to a point, are smooth, have no burr, are hollow at their base, and are formed of large cells throughout: no ruminant had ever antlered horns of this sort. They must, therefore, have been cavicorned

cores. Besides, no ruminant with antlers was ever seen with four bases to the horns. With regard to the rear ones, their structure is most perplexing, the main branch is hollow as in the *Bovidæ*, they have no burr or appearance of articulation; but at the same time they give undoubted proofs of having had two branches, the distinct bases of which are seen, and there is every reason to believe they had a third. No cavicorned core is known to be branched in this way, after the manner of the solid antlered horns of the *Cervidæ*, but at the same time they have no burr as all the *Cervidæ* have. They are smooth, they are not solid, as all the *Cervidæ* are, but hollow; at least, the central and outer ones are so. The horns in the *Cervidæ* always come off from the forehead much in advance of the occipital, with long parietals between. In the *Bovidæ* they come off exactly overhanging the occipital: so do these. In the specimen the plane of the occipital is exactly as in the *Bovidæ*; there are no distinct parietals, the frontals run up to the occipital crest, and there give off their cores. Therefore, both from structure and analogy, the rear horns of the Sivatherium were at least three-branched, and at the same time cavicorned! The dimensions of Col. Colvin's specimen are as follows:—

Measurements.

	Inches
Longitudinal diameter of pedicle of right back horn where contracted	5·8
Vertical ditto ditto ditto . .	3·3
Greatest width mutilated of occiput	15·5
Height of occipital from upper border foramen to top of cores. .	5·25
Breadth of the condyles (somewhat broken or compressed) . .	6·3
Interval between the surfaces of temporal fossæ behind the pedicles of horns	13·4
Length from the middle of a line drawn across the anterior margin of the base of front horns	13·5

[The specimen to which the above remarks refer was obtained by Colonel Colvin from the lower hills below and west of Nahun. It was figured and briefly described by him in the 'Journal of the Asiatic Society' for February 1837. It was also figured by Dr. Falconer in an unpublished plate of the 'Fauna Antiqua Sivalensis' (Plate A., fig. 2). In Captain Cautley's collection a large flat horn was found, which corresponded to Colonel Colvin's specimen: this is figured in the same plate (Plate A., fig. 5). Colonel Colvin's specimen is now in the Museum of the Edinburgh University; the flat horn is in the British Museum (Cat. No. 39,524). These specimens are also figured in Plate XXI. figs. 2 and 3 of this work, where a restoration of the skull by Mr. Dinkel (fig. 4) is also given, which will explain the structure and relations of the four horns better than any description.—Ed.]

II.—MS. Notes on Bones of Sivatherium not described in Memoir.

Atlas.—The form of the atlas, from two fragments which exist of it, appears to have been very different from that of all living ruminants. The body of the vertebra and the arc surrounding the medullary canal are not peculiar. The anterior articulating surface resembles that of the eland; the two cavities are continued to the median line, without any mesial ridge as in the eland. The posterior articulating surface resembles in every respect that of the buffalo. Below, the body of the vertebra is not distinct, as in the buffalo and eland, where on each side it forms a right angle, but the body passes into the transverse apophysis by a slightly inclined plane, as in the giraffe. As a result of this, the foramen in the transverse process is not concealed by the body of the vertebra. But the remarkable feature of the atlas consists in the form of the transverse process. In the ruminants this process is depressed; it is very large posteriorly, and diminishes gradually in front, where it presents a straight edge. In the Sivatherium the transverse process is much less developed. At its middle it is very narrow, but it expands a little at the two extremities of the bone, in such a way that the outer part of the process is concave towards the body. The four angles of the bone form almost a square, perhaps slightly wider in front than behind, but the extremities of the transverse processes are too worn to determine this point with certainty. Length of body, 3·3 inches; minimum breadth a little behind the middle of the body, 7·8; extreme breadth of articulating surface with axis, 6·7. The corresponding measurements in buffalo are 2·1; 10·4; and 5.

[The specimens of the atlas referred to are in the British Museum. Cat. Nos. 39,526 and 39,527. They are both figured in an unpublished plate of F.A.S. (B. 1 and 2).—Ed.]

Axis.—In form the axis is that of a ruminant. It resembles that of the eland and of the ox in the situation of the foramen, by which the vertebral artery enters the spinal canal anteriorly, and also in the form of the odontoid process and of the articulating surface of the atlas; below, at the middle of this surface, there is not the cleft seen in the eland, nor the echancrure observed in the buffalo. The spinous process projects a little more backwards. The posterior articulating surfaces project less backwards and are more distant from one another than in the eland. In this respect they resemble those of buffalo. Length of body with odontoid process, 7·6 inches; width of articulating surface with atlas, 5·7.

[This specimen is in British Museum, No. 39,528, and is figured in an unpublished plate of F.A.S. (B. 3).—Ed.]

Sternum.—The sternum agrees very nearly in form with that of *Bos urus* (British Museum skeleton). It is very deep and narrow on the upper or pectoral surface and rather broad on the inferior surface. It also widens behind and has the same pointed termination. It shows the five posterior hollow discs for the reception of the cartilages. The anterior keel-shaped portion is broken off. The *B. urus* shows seven discs for rib cartilages, viz. the six anterior for separate cartilages, and the last, or seventh, for the confluent cartilages of the posterior ribs. The sternum of buffalo is very broad and flat, and so is that of the deer; that of *Bos urus* alone resembling Sivatherium, but from *B. urus*, as well as from all other ruminants; the Sivatherium sternum differs in its complete ossification.

[The sternum referred to is in British Museum, and is figured in an unpublished plate of F.A.S. (C. 1.) See also Plate XXI. fig. 5.—Ed.]

Scapula.—A portion of the left scapula most resembles that of the camel. The spine is very near the anterior margin, and sufficiently perpendicular to the surface of the scapula, but the acromion process is less prominent than in the camel.

[See description of F.A.S. Plate C., figs. 2 and 3.—Ed.]

Humerus.—The deltoid crest is as prominent as in the horse. The tuberosities at the upper end rise less above the bicipital canal than in most ruminants. The greater tuberosity is deeply indented by a furrow through which the second head of the biceps passes. In the camel the external furrow or canal which is the deepest is also the narrowest, whereas in the Sivatherium the external furrow is broader than the internal. The lower end of the bone is broad, and has three well-marked ridges, of which the inner is broad and flat. Posteriorly the condyles are prominent and have a deep cavity between them, rather less narrow than in the camel. There is no hole in it. The tuberosities above the lower articulating surfaces are very prominent. The extreme transverse diameter of the lower end of a very large specimen is 7·8, whereas the transverse diameter at the middle of the articulating surfaces is only 6·5.

[See description of F.A.S. Plate C., figs. 4 and 5.—Ed.]

Bone of Forearm.—The forearm presents a sort of transition from the Ruminants to the Pachyderms. In the latter the ulna is generally separate from the radius, but in the ruminants the two bones are united throughout their length, and are only distinctly visible at their extremities. In the Sivatherium, as in the horse, a furrow runs throughout the whole

length of the bone, and at either end there is a fissure. The nature of the two bones is observed on the outer surface, where the ulna forms a prominent ridge along the posterior and outer angle of the bone. In the lower third, the radius retires from this ridge, and a longitudinal furrow is observed. The olecranon projects considerably behind the upper end of the radius. The latter presents three distinct articular pits for the corresponding prominences on the lower surface of the humerus; the innermost is the largest and the middle one the deepest. The anterior tuberosity below the articulation is very prominent. In the camel the ulna is invisible at the diaphysis; and the upper surface presents only two pits, the two outer ones being confluent. The lower end presents more marked elevations and depressions than in the camel. The cavity which receives the semilunar bone is much larger, and assumes an oval form in front. On the contrary, the depression for the cuneiform bone is smaller than in the camel. Both the depressions are very deep.

[For measurements, see F.A.S. Plate C., figs. 7, 8, & 9.—Ed.]

The *Carpus* is extremely like that of the buffalo, presenting the same number of bones similarly shaped, and with the same relative dimensions, except that they are a little higher. The cuneiform also has its posterior surface, not vertical as in the buffalo, but inclining downwards and backwards. The articulating surface for the pisiform being on this surface, inclines in a like manner. The pisiform has not been found.

[See description of Plate C., figs. 9, 10, 11, 12, and 13, in F.A.S.—Ed.]

Metacarpus.—In proportion as we descend the bones of the leg, the differences from the camel increase. The cannon bone does not at all resemble that of the camel and approaches nearer that of the buffalo. The relative proportion of its length and breadth is intermediate between these two animals; in the buffalo the length being to the breadth as $4\frac{1}{5}$ to 1, in the Sivatherium as 5 to 1, and in the camel as $8\frac{1}{2}$ to 1. The anterior surface over its upper third presents a more prominent ridge than in the buffalo. The posterior surface is more scooped out than in the buffalo. The nutritive foramen is situated on this surface at exactly the same spot as in the buffalo, viz. a little above the lower end. This lower end is also the same as in buffalo.

[See description of Plate C., fig. 15, in F.A.S.—Ed.]

Femur.—The superior end seen in front resembles that of the camel; it is flattened and without depression, but the trochanter rises more upwards than in the camel. From above, this extremity looks more like the buffalo's, on account of the transverse length of the articulating head and the

shortness of the neck. The articulating head is semi-cylindrical, instead of being spherical, as in the camel. The transverse diameter of the head is more than twice as long as the neck; in the camel they are about equal. The great trochanter is much larger than in the camel, but not so large as in the buffalo. At the inferior extremity the inner side is longer than the other. This end much resembles the corresponding part of horse. On the articulating surface there is a small ridge between the lower part of the pulley and the inter-condyloid fossa, which is not found in the camel. The oval cavity situated between the external condyle and the external border of the pulley is well circumscribed in the camel; but its direction, instead of being exactly transverse, as in camel, slants from behind forwards and outwards. At the lower part of the shaft, on the posterior external angle, is a depression about the same as in the buffalo. This depression does not exist in the camel, and is much more marked in the horse.

[See description of Plate D., figs. 1, 2, 3, and 4, in F.A.S. —Ed.]

Tibia.—The two depressions on the upper end are deeper than in the camel, and the anterior tuberosity rises higher towards the articulation. The lower end is rectangular, the transverse diameter being half as large again as the antero-posterior. The notch on the outer side is small and more in front than in the camel, the articulating surface for the fibula is also less developed. The posterior and inner angle of the shaft near the lower end has a well-marked groove, about two inches in length; in the camel this furrow is scarcely visible.

[See description of Plate D., figs. 5, 6, 7, 8, and 9, in F.A.S. —Ed.]

Tarsus.—The *calcaneum* is very similar to that of the buffalo. The heel is more compressed laterally. The superior angle is more acute. The *astragalus* is intermediate in form between that of the camel and that of the buffalo, but much nearer the latter. The anterior part of its lower surface does not present the deep transverse depression seen in the camel. The tarsus has but four separate bones, as is the case with ruminants, except the camel, the *scaphoid* being united to the *cuboid*. The superior articulating surface of this compound bone has three cavities, and differs from the buffalo in the circumstance that the middle depression is not separated by a well-marked depression, from a fourth small articulating surface on the vertical surface. The *cuneiform* has not been found.

[See description of Plate D., figs. 10, 11, 12, and 13, in F.A.S.—Ed.]

Metatarsus.—This bone, like the metacarpus, is of intermediate dimensions between the camel and buffalo, but is more like the latter. In the middle of the anterior end is a deep and well-defined furrow much more marked than in the buffalo; the upper part of the posterior surface has also a much deeper mesial depression than in buffalo. Extreme length, 16·4 inches; transverse diameter of upper end, 3·9; of lower end, 4·05; of middle of shaft, 2·1.

III.—Description by Dr. Falconer of Fossil Remains of Sivatherium in the Museum of the Asiatic Society of Bengal.

No. 327.—Fragment of lower jaw of *Sivatherium giganteum*, left side, of a very young animal, showing one molar embedded in germ in the alveolus, and part of one in front emerged from the alveolus. These are probably the last milk molar and the first true. The specimen includes behind the base of the ascending ramus and coronoid. The tooth in germ exhibits well the peculiar rugous reticulation of the enamel, so characteristic of the genus. The section in front shows the molar pressing down nearly to the inferior border of ramus with a very limited dental canal. From the Sewalik hills near Nahun, presented by Conductor Dawe.

No. 328.—Detached molar, lower jaw, with crown worn, covered with a little sandstone matrix. From the Sewalik hills. Presented by Colonel Colvin?

No. 329.—Superb specimen of the horn, showing the basal snag and nearly the whole of the broad leafy expansion, broken off only towards the apex; the convex surface shows four deep wavy ramified channels for blood-vessels of very large size and converging near the base; the horn is convex on one surface and concave on the other. It is very thick at the inner border, and becomes thinner outwards and upwards; the general form of the specimen is an irregular trapezium. The figure by Lieut. Baker shows the form and characters of the antler very well. From the Sewalik hills, Ganawur Khal, near the Haripal branch of the Sombe River. See Journ. As. Soc. iv. 506, Pl. XLIV. fig. 3, also v. 184, D. 3, 4. Presented by Conductor Dawe. This antler was found connected by matrix to the cervical vertebra (fig. 2 of Pl. XLIV. vol. iv. Journ. As. Soc.), and both were described by Lieut. Baker as belonging to a fossil elk.

No. 330.—Fragment composing half the molar of a *Sivatherium*. Presented by Colonel Colvin.

No. 331.—Fine specimen of second cervical vertebra nearly entire and deficient only at the anterior and upper part of the spinous process. The bone had belonged to an old animal, as the epiphyses are completely synostosed and the ridges and depressions strongly marked. The vertebra is remarkable for the very great width of the posterior surface measured at the extremities of the aliform expansion of the transverse processes, this dimension considerably exceeding the entire height. The body of the bone is broad at the upper articulating surface; the odontoid process

is thick, and there is a very rapid contraction immediately below the vertebral foramen, which is situated high up on either side; the median ridge along the under side of the body is in great relief and thick and prominent at its extremity. The form of the body differs from that of all other ruminants in the great divergence and spread of the posterior continuation of the inferior transverse processes, which terminate in a thick projecting mass, instead of being inflected downwards and inwards as in the bovine ruminantia; the spinous process also differs remarkably, inasmuch as it appears to have been a short thick mass instead of a leafy expansion, as in most other ruminants. The inferior articulating surface is partly concealed by matrix, but it appears to be oblique and deep; the posterior oblique processes are broad and flat. The length of the superior vertebral laminæ is short as compared with other ruminants. The projecting edge of the odontoid process is slightly broken off. In the aggregate of its characters, the axis of the *Sivatherium* is remarkable for shortness and thickness.

Dimensions.

	Inches
Length of vertebra measured from termination of posterior inferior surface to edge of odontoid.	7·2
From ditto to margin of anterior articular surface	6·1
Width of articulation with atlas	5·6
Ditto of constriction of body	3·6
Ditto between the posterior terminations of the transverse processes, partly restored on the right side	9·5
Vertical diameter of vertebral canal	1·9
Transverse ditto ditto	2·

Found with specimen No. 329, and presented by Conductor Dawe. See Journ. As. Soc. iv. 506, Pl. XLIV. fig. 1.

No. 332.—Specimen of cervical vertebra, probably the fourth, more mutilated than the axis. The anterior and posterior articulating surfaces of the body present, as also the two posterior oblique articulating surfaces; the anterior oblique articulating process on the right side is partly shown, on the left broken off at its base, as also the spinous process; on the left side a part of the superior and inferior transverse processes (Owen) is shown; on the right they are broken off close to their base. A good deal of matrix remains on the fossil, concealing some of the parts. The anterior articulating head of the body is ovate in its outline as in the ox, but more vertical in its direction. The posterior articulating cup is very deep. The posterior oblique articulating processes are very broad. Vertebral foramina large with a short canal. The bone is too much mutilated to afford dimensions, but corresponds in dimensions with the axis, and was found in the same place adhering to the large antler No. 329. All three probably belong to the same animal.—*Journ. As. Soc.* vol. iv. p. 506, Pl. XLIV. fig. 2.

No. 333.—Sixth cervical vertebra, showing the anterior and posterior articulating surfaces, the former nearly entire; the bases of the anterior and posterior oblique processes present, but the articulating surfaces broken off, as also the spinous and transverse processes. Vertebral foramen is present, on left side, of enormous size, with an exceedingly short canal.

The articular head of the body is very convex and broad and less pointed downwards than in the ox; its general direction being also more vertical. The length of the body is very short for the other dimensions.

Dimensions.

	Inches
Vertical diameter of articular head	3·4
Transverse ditto ditto	2·6
Vertical ditto of vertebral foramen	1·1
Transverse ditto ditto	1·1

From near Nahun. This probably came from the same place as the three last.—*Journ. As. Soc.* vol. vi. p. 899.

No. 334.—Mutilated specimen of vertebra (either last cervical or first dorsal) presenting the greater part of the body with the articular surfaces entire, but the neural arch and apophyses broken off; less mutilated on the right side than on the left, and it is there seen that there was no vertebral foramen: the posterior articulating surface shows, on its right margin, the smooth depression of a costal articulation: the anterior articulating surface is very large, globular, and projecting; the posterior shows a deep cup, which is oblique in its vertical direction, indicating that the bone is probably the last cervical. Too much mutilated to furnish any dimensions. From the Sewalik hills. Presented by Conductor Dawe.—*Journ. As. Soc.* vi. 899.

No. 335.—Lower end of humerus left side, showing the whole of the articular head with only a short portion of the shaft. Shaft continuous with the inner condyle, the outer condyle projecting outwards with great obliquity as in the rhinoceros. The outer condyle shows markedly the projecting ridge bisecting its articulating surface, as is normal in the ruminants.

Dimensions.

	Inches
Width of articular surface at lower border	5·9
Ditto greatest width at the upper part of outer condyle	7·25
Breadth of articular surface inner condyle	3·9
Ditto outer ditto	2·65

No. 336.—Fragment comprising the upper half of the anti-brachium right side, showing a considerable portion of the shaft and the whole of the articular surface of the radius, which is entire; the olecranon broken off; a small splint of the ulna adhering to the shaft. The articular surface of radius shows the depressions for the corresponding surface of the humerus; the inner is large and nearly circular, inclining obliquely inwards to a lower level than the outer. The outer side of the bone is marked by a salient tuberosity. Shaft contracts rapidly from the articular surface, and, in front, immediately below the outer articular surface, there is a deep rough pit.

Dimensions.

	Inches
Extreme width of articular head	7·1
Transverse diameter of articular surface	5·8
Ditto of inner surface	3·2
Ditto of outer ditto	2·8
Antero-posterior diameter of inner surface	2·85
Ditto of outer ditto	3·3

From the Sewalik hills. Presented by Colonel Colvin.—*Journ. As. Soc.* vol. v. 182.

No. 337.—Nearly counterpart of No. 336, but of the left side and of smaller size. It shows the articular surface still more perfectly, and more especially the part in apposition with olecranon. Reference and source same as last.

No. 338.—Fine specimen of cervical vertebra, probably the fifth, showing the whole of the body and the greater portion of the apophyses. It agrees very closely in general form and dimensions with No. 332, the various processes being more entire, but more concealed by matrix; the body is short, the anterior articular head forms a broad oval, broader and more abruptly pointed than No. 332. The posterior articular cup is nearly circular, deep, and with a raised rim. It is very oblique in the vertical direction.

The superior and inferior transverse processes are separated from each other by a broad fossa as in *Bos*. The oblique processes show broad articular surfaces and the base of the spinous process presents a stout projection with an oval section. A good deal of sandstone matrix fills the intervals between the different apophyses, the spinal canal and the vertebral foramina.

Dimensions.

	Inches
Length of body from articular head to posterior border of articulating cup	6·
Vertical diameter of articular head	2·9
Transverse ditto at base	2·3
Vertical ditto of articulating cup	3·3
Transverse ditto ditto	2·8

From the Sewalik hills. Presented by Conductor Dawe. This specimen, in conjunction with Nos. 332, 333, and 334, shows the four last cervical vertebræ, the atlas and third being alone wanting in the collection.

No. 339.—Lower end of humerus, left side, showing both condyles with a portion of the shaft attached; the inner condyle as in No. 335, the dividing ridge upon the articular surface of the outer condyle is very prominent, and the articular surface is in fine preservation. The exterior surface of the outer condyle forms an irregular depressed disc. This specimen is in two pieces.

From the Sewalik hills. Presented by Colonel Colvin. See Journ. As. Soc. v. 182. This specimen is of smaller size than No. 335, but the articular surface is better preserved. It agrees in size with the articular surface of the radius, No. 337, so as nearly to match.

No. 340.—Fine fragment comprising the inferior half of the right antibrachium, the fibular portion being broken off, but showing the whole of the articular surface of the radius, which agrees very closely with that of the bovine ruminants; the bone is enormously large when compared with the radius of the recent Gour.

Dimensions.

	Inches
Length of fragment	9·5
Width of articulating head	5·6
Antero-posterior diameter of head at the inner side	3·5
Transverse diameter of shaft where broken	3·9
Vertical ditto	2·8

The medullary cavity is filled with a solid mass of crystals of carbonate of lime.

This and the six following specimens, from the Sewalik hills, were presented by Colonel Colvin.—*Journ. As. Soc.* v. 182.

No. 341.—Lower end of radius left side, resembling exactly the former, but still more perfect in its articular surface, which is as complete as in a recent bone.

The dimensions are smaller than in the preceding specimen.

	Inches
Width of articulating head	5·1
Height of styloid apophysis of ulna	1·3

No. 342.—A similar specimen of same side, alike in every respect, except that the portion of the shaft is shorter.

No. 343.—Another of the same side, agreeing in every respect, except that the shaft of the bone is considerably longer, comprising the lower two-thirds. Dimensions smaller than the two last. Probably belonged to a female. The shaft of the bone, instead of being broad and flat, is compressed laterally, so as to form an angle upwards with considerable depth, showing a somewhat triangular outline in section.

No. 344.—Fragment of lower end of left radius, the outer portion of the lower articulating surface broken off.

No. 345.—Specimen comprising the inferior third of the right radius, with the carpal bones and upper part of the metacarpus connected together by matrix; the two principal bones being bent, so as to be parallel to each other. The bones are so enveloped by matrix as to present no distinct character; the core of the metacarpal is divided in section by a vertical plate of bone showing its composite nature.

Dimensions.

	Inches
Width of articulating head of radius partly broken off	5·4
Ditto of head of metacarpus	4·8

No. 346.—Fine specimen consisting of the left metacarpus perfectly entire, cleared of matrix. The bone corresponds exactly, in the form of its articular terminations, with the same bone in the Gour, but is proportionally shorter, thicker, and broader in its dimensions. The articular epiphyses are synostosed, indicating the animal to have been adult, but probably a female, as it is considerably smaller than No. 345.

Dimensions.

	Inches
Length of bone	13·
Transverse diameter of carpal articulating surface	4·3
Antero-posterior ditto inner side	2·4
Ditto outer side	1·8
Transverse diameter of inferior articular surface	4·3

The interval between the divisions of the articular ends below is very narrow and the salient ridge between the pulley surfaces very salient, as in *Bos*.

No. 347.—Fine specimen comprising the upper half of the tibia, showing the whole of the articular surface nearly complete; the form

agrees closely in every respect with that of *Bos*, the posterior outer angle being deflected downwards exactly as in *Bos*: the longitudinal ridge along the shaft proceeding from the tubercle is thick and massive, with a deep fossa on its outer side.

Dimensions.

	Inches
Length of fragment	9·2
Transverse diameter of articular head	6·8
Antero-posterior diameter of inner articular surface	3·5
Ditto of outer	3·8

Purchased at auction along with head of *Elephas insignis*.

No. 348.—Fragment comprising nearly the whole length of the shaft of the right tibia with the articular surface below, the upper end broken off a little below the tubercle; the articular surface corresponds closely with that of the *Gour*; the bone being proportionally much thicker and shorter.

Dimensions.

	Inches
Length of fragment	15·5
Transverse diameter of articular head	5·
Antero-posterior ditto of outer cup	3·5

This and the remaining specimens from the Sewalik hills. Presented by Colonel Colvin.—*Journ. As. Soc.* vol. v. p. 183.

No. 349.—Lower end of left femur, presenting the condyles and rotular pulley with a short portion of the shaft. A good deal of obliquity of direction of the rotular pulley from within outwards; borders of pulley more or less injured; condyles nearly of equal size; form and depression closely resembling what are seen in *Bos*.

	Inches
Length of fragment	8·5
Transverse diameter of articular head	6·1
Interval between condyles	1·4
Length of rotular pulley	3·7
Antero-posterior diameter of inner condyle	3·6
Transverse ditto	2·4
Antero-posterior diameter of outer condyle	3·7
Transverse ditto ditto	2·1

The form of shaft of bone not well shown.

No. 350.—Astragalus, right, nearly entire, partly covered with matrix, but the impressions and articular surfaces sufficient to show that it resembles in general form the astragalus of *Bos*, the proportion being thicker, broader, and shorter.

	Inches
Length of bone	4·8
Width of lower articular	3·3
Ditto upper ditto	3·4

No. 351.—Compound bone of tarsus, including scaphoid, cuboid, and two cuneiform forms, of left side.

General form and articular surface like those of the ordinary ruminants.

	Inches
Transverse diameter	4·5
Antero-posterior ditto	4·5

No. 352.—Left calcaneum, apophyses broken off, but presenting the whole of the articular surfaces as distinctly as in the recent bone.

	Inches
Length of fragment	5·3
Ditto astragalus articulation	3·3
Height of bone	3·8

No. 353.—Right calcaneum, presenting the whole of the long apophysis and the base of the articulation with the astragalus; lateral portion broken off. The bone is short, thick, and stout.

	Inches
Length of apophysis to articular surface	5·
Height of ditto	2·8

No. 354.—Lower end of right tibia, presenting the whole of the articular surface with an extraneous piece of bone adhering to the side.

No. 355.—Proximal metacarpal or metatarsal phalanx of outer toe, left side; a thick and massive bone as compared with the ordinary ruminants. The proximal articulation very deep; distal articulation very unequal and oblique.

	Inches
Length	5·1
Height of proximal articular surface	2·5
Width of ditto	2·5

No. 364.—Middle phalanx of toe, of large size, but very short.

XIII. THE FOSSIL BOVIDÆ, CERVIDÆ, AND ANTILOPIDÆ OF INDIA.

[THE fossil *Bovidæ*, *Cervidæ*, and *Antilopidæ* of India, have still to be described.

Dr. Falconer distinguished at least six new species of *Bovidæ*, among the Sewalik fossils, which he designated in a manuscript synopsis, *Hemibos triquitriceras*, *Amphibos acuticornis*, *Amphibos elatus*, *Amphibos antilopinus*, *Bos Sivalensis*, and *Bos occipitalis*. The two first are figured in unpublished plates of the 'Fauna Antiqua Sivalensis' (Plates H. and I.), by referring to a description of which, further on in this volume, the numbers of the specimens in the Catalogue of the British Museum will be found. Outline sketches of *Bos Sivalensis* are among the unpublished drawings for the Fauna deposited in the British Museum; and the specimen described under No. 562 of the Catalogue of the Museum of the Asiatic Society of Bengal was probably *Bos occipitalis*. There are no means of identifying the two remaining species. References to the Sewalik *Bovidæ*, with figures by Messrs. Baker and Durand, will also be found in the 'Journal of the Asiatic Society' for October, 1835, vol. iv. p. 569. Dr. Falconer also described two species of fossil *Bovidæ* from the valley of the Nerbudda in his Catalogue of the Museum of the Asiatic Society of Bengal, viz. *Bos Palæindicus* and *Bos Namadicus*. The former is figured in an unpublished plate of the 'Fauna Antiqua Sivalensis' (G.), in the description of which the catalogue numbers of the specimens in the British Museum are given, and from which the figures in Plate XXII. have been copied. Brief descriptions and figures of the fossil buffaloes of the Nerbudda valley by Dr. Spilsbury will also be found in the 'Journal of the Asiatic Society,' vol. iii. p. 399, vol. viii. p. 952, vol. ix. p. 551, vol. x. p. 626, and vol. xiii. p. 765.

The Sewalik Collection in the British Museum also contains numerous remains of *Cervidæ*. In a manuscript synopsis of Sewalik fossils by Dr. Falconer, two unnamed species of *Cervus*, a third, *Cervus Palæindicus* and a species of *Dorcatherium* (*moschinum*), are entered under the head of *Cervidæ*.

DESCRIPTION OF PLATE XXII.

Bos Palæindicus and Bos Namadicus.

Fig. 1. Shows the cranium and horns of *Bos Palæindicus* from the Nerbudda, about one-eighth of the natural size. The drawing is a restoration from several specimens in the British Museum (Cat. Nos. 39,759 and 39,715). These specimens were ascertained to belong to the same individual, and the restoration has been executed by Mr. Dinkel in accordance with an outline drawing found among Dr. Falconer's papers. The separate specimens are also figured in an unpublished Plate of the Fauna Antiqua Sivalensis. (See pages 280, 546, & 554.)

Fig. 2. Lateral view of same skull as shown in fig. 1, one-fifth of the natural size.

Fig. 3. Section of horn of same specimen, one-fifth of the natural size.

Fig. 4. Fragment of cranium showing forehead, portion of right horn, and left horn-core of *Bos Namadicus*, one-tenth of the natural size. The specimen has been drawn by Mr. Dinkel from the original in the British Museum (Cat. No. 39,760), and is also figured in an unpublished Plate of the F. A. S. (See pages 287 & 545.)

Fig. 5. Profile view of another cranium of *Bos Namadicus*, one-fifth of the natural size, drawn by Mr. Dinkel from the original in the British Museum. Cat. No. 39,758. (See pages 280 & 545.)

Fig. 6. Section of horn of *Bos Namadicus*, one-fifth of the natural size. (See pages 286 & 545.)

Fig. 1.

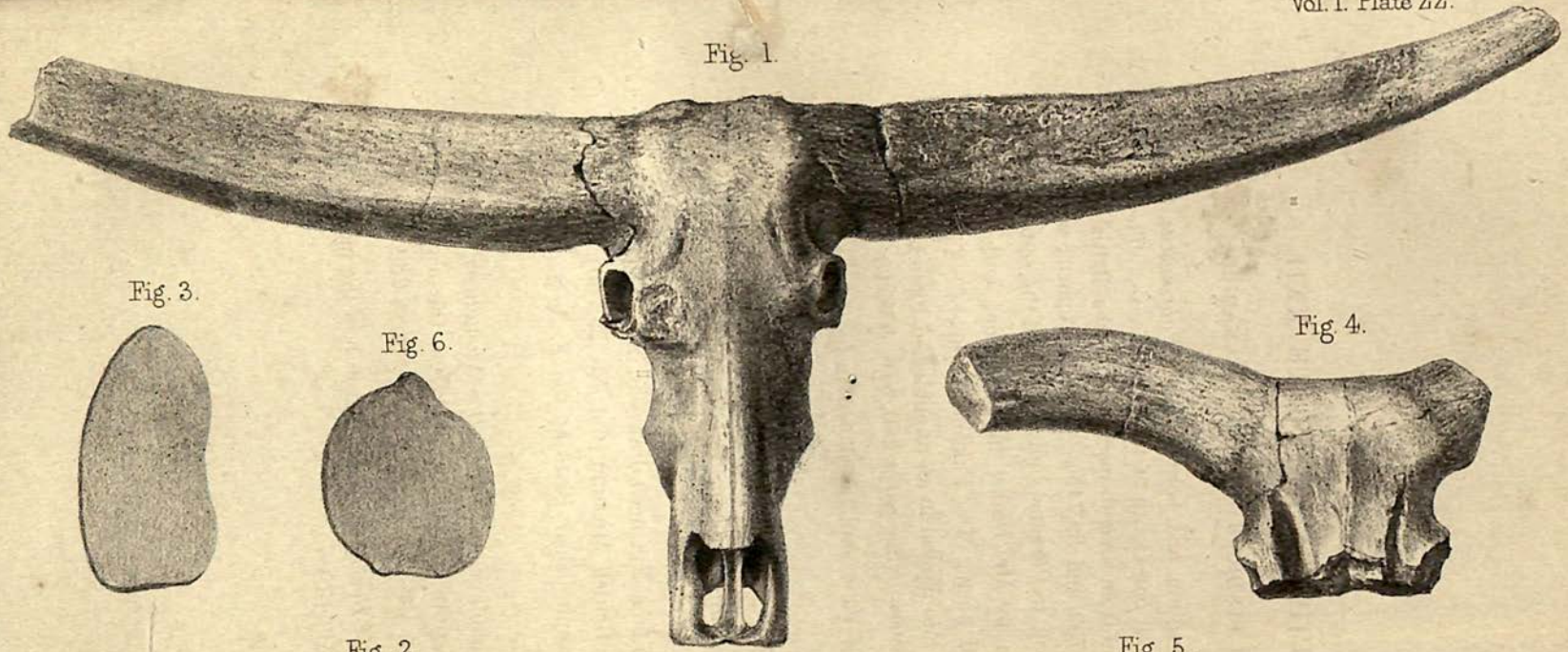


Fig. 3.

Fig. 6.

Fig. 4.

Fig. 2.

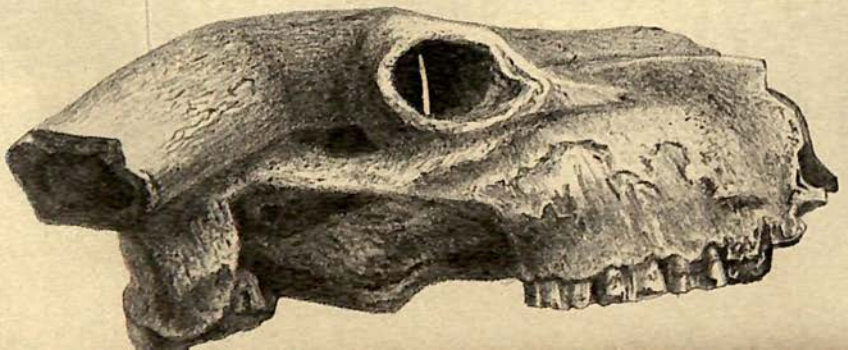
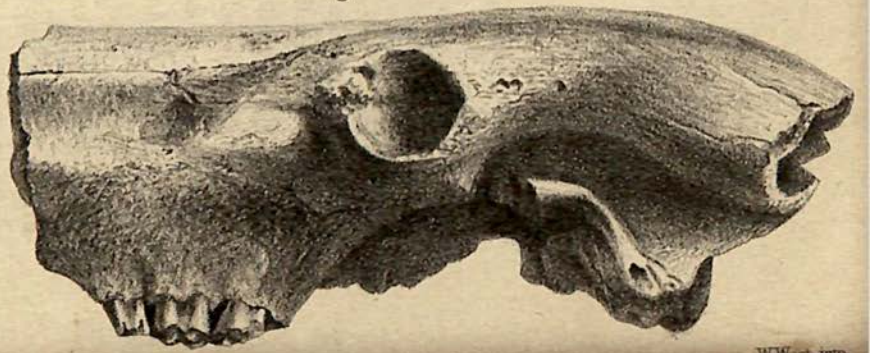


Fig. 5.



W.West imp.

Dr. F. also refers to numerous remains of *Cervus* in his Catalogue of the Museum of the Asiatic Society of Bengal; and a description with figures of vertebræ and antlers of the 'fossil Elk of the Himalayah,' by Lieut. Baker, but subsequently referred to Sivatherium by Dr. Falconer (see page 273), will be found in the 'Journal of the Asiatic Society of Bengal' for September, 1835, vol. iv. p. 506. Another fossil species of *Cervus* from the valley of the Nerbudda was designated by Dr. Falconer, *Cervus Namadicus*, but has not been described. Dr. Spilsbury, in his account of fossils found in the valley of the Nerbudda, refers to fragments of upper and lower jaws and teeth of deer. (See Journ. As. Soc. vol. x. p. 626.)

The Sewalik fossils also included several species of Antelopes which were designated by Dr. Falconer *A. Palæindica*, *A. gyricornis* and *A. picta*, in a manuscript synopsis. Brief descriptions of some of these Antelopes with figures, by Messrs. Baker and Durand, will be found in the 'Journal of the Asiatic Society,' vol. iv. p. 569, and vol. xii. p. 769. The *Antilope Palæindica* is also described by Dr. Falconer in the Catalogue of the Museum of the Asiatic Society of Bengal, and the specimen thus designated is said to agree closely with the Sewalik fossil Antelope, described and figured by Capt. Baker, in the 'Journal of the Asiatic Society' for September, 1843. Capt. Baker's specimen is now in the British Museum (No. 39,594), and is represented in Plate XXIII. from original drawings by Mr. Dinkel. Among the Sewalik specimens in the British Museum there are also remains of an Antelope with twisted horns, probably the *A. gyricornis* of Falconer. —Ed.]

I.—Description by Dr. Falconer of Remains of Large Bovine Ruminants from the Sewalik Hills, in the Museum of the Asiatic Society of Bengal.

No. 562. *Bos.*[1]—Fine skull of a bovine ruminant, nearly perfect, from the occiput on to the diastema, showing the zygomatic arches, temporal fossæ and the whole of the spheno-palatine region, together with two lines of molars, *in situ*; the crowns of those on the left side broken off; the three posterior molars on the left side nearly entire; a horn-core is present on the left side, absent on the right through a fracture, which has carried it off below the base. The cranial part of the skull differs remarkably from all known bovine ruminants in this respect, that the occipital bone appears to terminate at the occipital crest, or close to it, and that no part of the parietals enters into the occipital plane. The horns are pyriform in section, with a very sharp edge behind and a broad surface in front; they are closely approximated on

[1] *Bos occipitalis*, Falc.?—[Ed.]

the brow, and start outwards and upwards, but curve forwards towards their tip. The plane of the frontal is flat to between the commencement of the horns, and then descends in a sudden curve between the horn-cores, to meet the plane of the occipital at an obtuse angle. The occipital crest is very prominent; orbital rim also prominent, the lachrymal bones present rough tuberosities at the orbital margin, as in the bovine group; there is also no lachrymal fissure; the two supra-orbital foramina very large. The nasals are received into an angular fissure of the frontals, their apices ascending nearly to a line with the anterior border of the orbit. The orbits differ in a remarkable manner from those of the ordinary bovine ruminants, in having their greatest diameter in the vertical direction, instead of antero-posteriorly. Between the supra-orbital foramina there is a raised portion of the surface of the frontal of a horse-shoe shape, about a line in thickness, and with a rugous fimbriated margin about two inches in breadth, the sinus at the posterior part passing gradually into the surface of the frontal. This rugous disc is unknown in other ruminants. The maxillaries contract abruptly in front of the orbits; their tuberosities are very prominent.

Teeth.—The three posterior molars on the left side are well worn, showing the animal to have been fully adult, and a large accessory pillar, narrow and compressed, but of considerable depth, is seen in the sinus between the two barrels of each molar on its inner side, as in the bovine ruminants. The palate is broad.

Dimensions.

	Inches
Teeth from occipital condyles to commencement of diastema	12·6
Ditto from summit of occipital crests to apex of nasals	8·6
Width at posterior margin of orbits	7·7
Ditto at anterior ditto	6·
Constriction of maxillaries in front of orbits	5·5
Ditto of frontals behind orbits	6·9
From base of occipital to summit of occipital crest	5·1
Width of occipital region measured at the pars petrosa	8·5
Height from surface of palate to frontal	7·
Width between outer border of condyles	3·8
Distance between occipital crest and base of horn	1·1
Length of temporal fossa	5·5
Interval between base of horns	2·
Height from palate to broken extremity of nasals	4·5
Length of contraction between base of horn and posterior margin of orbit	1·9
Vertical diameter of left orbit	2·7
Antero-posterior diameter of left orbit	1·9
Vertical diameter right orbit	3·
Antero-posterior ditto	2·
Length of line of molars (5) right side	4·9
Greatest width of palate	3·3
Length of left horn-core fragment	9·
Antero-posterior diameter at base	5·
Thickness of ditto at ditto	3·
Antero-posterior diameter near broken tip	3·4
Transverse ditto	2·7

The dimensions of the two orbits differ a little in consequence of crushing on the right side. The principal distinctive marks are: 1. The occipital not rising above the occipital crest. 2. The great narrowness of the parietal region between base of horn and occipital crest. 3. The close approximation of the horn-cores. 4. The short

interval between the base of the horn and the posterior border of orbit. 5. Projection of orbits above plane of frontal. From Colonel Colvin's collection.

No. 571. *Bos* ——?—Cranium of a good sized bovine ruminant, in the cranial portion nearly entire, together with the maxillaries on to the diastema; nasal bones wanting. Specimen shows core of left horn a good deal abraded, the right broken off, but the specimen is so much enveloped by matrix as to conceal all the principal parts; the occipital, parietal, and frontal regions resemble 562, of which this may have been a female.

No. 572. *Bos* ——?—Fine fragment comprising lower jaw, right side, showing the last five molars *in situ*. The teeth correspond in pattern of crown and accessory pillars with the bovine ruminants; they are well worn, and the posterior talon of the last is broken off. The compressed accessory pillar between the barrels agree closely with the corresponding teeth of upper jaw of No. 562, of which species this was probably the lower jaw.

	Inches
Estimated length of last five molars	5·5
Length of fragment	5·7
Height to alveolus, behind	2·8
Ditto, in front	1·8

No. 574. *Bos* ——?—Fragment comprising the terminal portion of a curved and conical horn-core, probably bovine, which shows no indication of a ridge on its upper edge.

	Inches
Length of fragment	5·8
Antero-posterior diameter at base	2·2
Transverse ditto	1·9

No 575. *Bos* ——?—Portion of base of a thick horn-core of a bovine ruminant, presenting a different section from the horn-core of 562.

	Inches
Long diameter	4·2
Short ditto	3·8

No. 576. *Bos* ——?—Fragment of horn-core, presenting the character of 562, with a sharp upper edge.

No. 577. *Bos* ——?—Fragment of horn-core in two pieces, presenting nearly a square section like 575, but of smaller size; fitting a detached frontal portion of cranium.

	Inches
Length of fragment of horn	9·5

Subsequently the frontal portion of this specimen was discovered. It is the specimen referred to by Mr. E. Blyth as identical, or nearly so, with Capra Sakeen (Bl.), *vide* Journal As. Soc. xi. p. 103.

No. 578. *Bos* ——?—Fragment of a horn-core presenting nearly a square section, with a sharp edge on one side, differing in form from 562.

No. 579. *Bos* ——?—Another portion of horn-core of similar form to last, with sharp edge on the concave side, belonging to upper part of core. Section nearly triangular.

No. 580. *Bos* ——?—Part of cranium of a middling-sized ruminant,

showing only occipital and part of sphenoid, too defective for further determination.

No. 607. *Bos* ——?—Skull nearly complete from the occipital condyles on to the diastema, with two lines of molars, both orbits and the right zygomatic arch; both horn-cores broken off, and the upper lamina of the frontal bone denuded, so as to afford no characters in that part. The skull is nearly of the same size as 574. The molars are far advanced in wear, and show the compressed accessory pillar between the barrels, exactly as in 572. Rime of orbits more or less damaged, but the left shows the great vertical height seen in 572. From Sewalik hills, sandstone matrix.

II.—Description by Dr. Falconer of Fossil Species of Bos from the Nerbudda, in the Museum of the Asiatic Society of Bengal.

No. 18. *Bos Palæindicus.*—Cranium with the cores of 2 horns attached, broken off in front across the orbits, where it is much mutilated; occiput, right condyle, and left styloids, with the occipito-sphenoid region and zygomatic fossa on either side nearly entire. Core of right horn in 4 pieces, extending nearly to the apex. Left core in 3 pieces, of less extent. Dimensions—Length of right core 2 feet 9 in.; breadth at base $6\frac{1}{2}$ in.; thickness $4\frac{1}{4}$ in. Length of left core 1 foot 11 in.; breadth of skull at base of occiput 13 in.; ditto from occipital condyles to plane of frontal 10 in. The horn-cores spread out more horizontally, and with a less inclination upwards than in the existing wild buffalo, slightly concave anteriorly and convex behind. A cord stretched between the tips would subtend the plane of the cranium behind the frontal. In all these respects it differs from the existing wild buffalo, and so far as the horizontal offset is concerned it approximates to the Gayal, from which, however, it differs in the flattened form of the horns and in every other respect. The posterior border of the cores encroaches much upon the temporal fossa, which is narrow. These characters are so constant, as shown by still better specimens in the British Museum, that there can be little doubt that the species is distinct from the existing wild buffalo. The specimen is in a soft friable condition, and covered with calcareous matrix; probably belonged to an adult male of large size. This fine specimen has remained unfigured in the Journal. It would appear to have been the intention of Mr. J. Prinsep to have described and drawn it; this he postponed, expecting similar specimens from Conductor Dawe. His subsequent fatal illness prevented this design from ever being carried out (*vide* Jour. As. Soc., vi. 489). Found by Dr. Spilsbury, near Sagauni (or Sejouni).

No. 19. *Bos Palæindicus.*—Mutilated cranium broken off across the orbit with the base of the left core attached, the right core with the parietals and vertex broken off. Occiput nearly entire with the condyles, occipito-sphenoid region and right styloid and mastoid entire, together with the left temporal fossa. Width of core at base $6\frac{1}{2}$ in.; thickness $4\frac{1}{2}$. Width between the outer margin of occipital condyles

5½. Long diameter of occipital condyle 25·75 in.; transverse 1·75. Foramen magnum, antero-posterior diameter, 1·7 in.; transverse diameter 1·75 in. This would appear to be an adult male specimen of same species as No. 18. From Hoshingabad (*vide* Jour. As. Soc., vol. viii. 950, figs. 3 and 9).

No. 20. *Bos Palæindicus.*—Specimen consisting of a nearly entire cranium broken off anteriorly at the diastema, and bearing the cores of both horns, the right broken off a little above the base, the left 9 inches long. All the molar teeth on both sides protruded and worn, the occipital portion agrees in form with the large specimen No. 18, of which it would appear to be an adult female, judging from the less prominent development generally and the smaller size of the horns. Length of specimen 17½ in.; height from sphenoid to surface of frontal 8 in.; width of skull at constriction between the horn-cores and orbits 8¼ in.; width of brow between middle of orbits 7½ in. Length of brow from vertex to upper margin of orbit 7½ in.; length of line of molars, left side, 6½ in.; greatest width of left horn 5 in.; thickness 3 in.

The left horn-core, right condyle, right styloid, left zygomatic arch, and glenoid surface, palate, occiput, frontal, and both orbits, also the two maxillaries, are nearly entire. Nasals broken off. The specimen is encrusted with a hard calcareous gritty matrix. (From Hoshingabad.) Memo.—This cranium is described by Mr. James Prinsep, and a series of 8 different dimensions as compared with a skull of a buffalo (not stated whether wild or tame) prepared by Dr. Evans (Journ. As. Soc., vol. iii. p. 399).[1]

No. 21. *Bos Palæindicus.*—Specimen comprising left maxilla nearly complete in height and containing 6 molars protruded from the jaw: all the rest of the skull wanting. Length of line of molars 6 in.; height from edge of molars to upper margin of the fragment 9¼ in. Probably adult.

No. 22. *Bos Palæindicus.*—Lower jaw, left side, comprising nearly the whole length of horizontal ramus, broken off in front near symphysis, and behind at the offset of the ascending ramus in a line with the molars, containing 6 adult molar teeth, all protruded and worn, but not of an old animal. The grinding pattern is a little obscured by matrix, which encrusts the specimen; but it would appear to correspond with *Bos Palæindicus.* Length of fragment 13·25 in.; length of line of molars 7½ in.; height of jaw at the last molars 4 in.; at the anterior edge of the 1st premolar 2¼ in. Length of diastemal portion 2½ in.; greatest thickness 1¾ in.

No. 30. *Bos Namadicus.*—Enormous core of bovine ruminant, encrusted with matrix, much curved in the outline and nearly circular in section. Girth, 5 inches above base, 1 foot 7 in. Length along convex

[1] Respecting this specimen Mr. J. Prinsep writes in Journ. As. Soc., vol. iii. p. 399:—'The direction of the horns in the *Hoshingabad* fossil skull give it at first sight the appearance of a buffalo's head: and the convexity and breadth of the forehead, as well as the angle of the occiput, both tend to rank it with this genus; or at least certainly to separate it widely from the Aurochs and the domestic ox, as described by Baron Cuvier.' —[Ed.]

curve 3 feet 8 in. Diameter where tip is broken off 3 in. This horn-core differs in size, form, and curvature from any known ruminant. It is much more circular than that of the Gour or Gayal, in which respect it differs still more than the *Bos Palæindicus*, and it would appear to indicate a distinct fossil species now extinct.

The core is hollow throughout, having a thin shell. Surface encrusted thickly with matrix, which requires removal. Consists of 2 fragments, which join; a portion of the tip is wanting.

No. 31. *Bos Namadicus.*—Fragment of horn-core, left side, detached, presenting the same characters as No. 30, namely, a curved outline and nearly circular section; it is less covered with matrix, and at the upper and convex edge shows a ridge similar to *Bos grunniens*, which it resembles also in circular section. The specimen is partly covered with hard sandy matrix and is harder and stronger than the other bovine remains above described. Length 11 inches; girth near base $14\frac{3}{4}$ in.; at small end of specimen 13 in. (From Jahnsee Ghat on the Nerbudda.)

No. 32. *Bos Palæindicus.*—Detached fragment of horn-core with a slight portion of the frontal attached to its base; the left side; hollow and in the soft condition of the other Nerbudda fossils.

Length $11\frac{1}{2}$ in.; girth near base $19\frac{3}{4}$. Long diameter 7 in.; short diameter $4\frac{1}{2}$ in.

No. 33. *Bos Namadicus.*—Mutilated cranium, presenting the occipital and sphenoidal region nearly entire; left occipital condyle and right mastoid complete; occipital and frontal surfaces perfect, from superior margin of foramen magnum to the commencement of the nasals; cores of both horns broken off—on the left side within the base of the pedicle of the core—and on the right side the fracture includes the base of the core, the margin of the frontal and orbit, all of which are removed. A portion of the upper border of left orbit remaining. The frontal plane longitudinally is slightly convex with a shallow concavity upwards, between the commencement of the horn-cores. The vertex projects posteriorly to a great extent, so as to overarch the plane of the occipital condyle $2\frac{3}{4}$ inches. Occipital region concave from above downwards; in these two respects differing very notably from the skulls of the Gour and Gayal. Judging from the section of the core on the left side, it was more or less cylindrical in form; in this respect also differing from these two species.

Length of specimen from vertex to broken margin in front, 13 inches; height from posterior edge of body of sphenoid to vertex, about $8\frac{1}{2}$ inches; width of skull at base of occiput, $9\frac{1}{2}$ inches; height of occipital surface from inferior margin of foramen magnum to posterior border of vertex, $7\frac{1}{4}$ inches; long diameter of occipital condyle, $2\frac{3}{4}$ inches; short ditto, 1·6 inch; width of frontal at constriction behind orbits, $8\frac{1}{4}$ inches. Dr. Spilsbury states that this cranium and the specimen No. 31 were found in the same place; they are marked No. 1 and No. 2. In conjunction with the huge horn-core No. 30, they would appear to afford conclusive evidence of a fossil species of Bos from the Nerbudda, distinct from *Bos Palæindicus* and Gour and Gayal, or from any other described

existing form. From the complete synostosis of the two frontals, it is inferred that the animal was an aged adult; and the smaller size of the horn, as compared with specimen No. 30, would seem to indicate that it was a female.[1]

The forehead of this specimen is flat and slightly concave above; it is square, taking the base between the orbit; its height is about equal to its breadth. The horns are attached to the extremity of the highest salient line of the head; the plane of the occiput forms an acute angle with the forehead (it is over-arched), and the plane of the occiput is nearly quadrangular, instead of semi-circular, all these being distinctive characters of the Taurine *Bovidæ* (ox), as contrasted with the Bisons and Aurochs. (*Vide* Cuvier, Ménagerie du Muséum, article 'Zébu,' p. 4.)

No. 34. *Bos Namadicus.*—Specimen of the posterior part of the cranium, nearly perfect on the left side from the vertex to the middle of the orbit; mutilated on the right side; the inter-frontal suture, and that uniting the two lateral occipitals with the superior occipital are widely open, showing that the animal was very young, which is further borne out by the dimensions. The left horn-core is attached to the extent of about 5 inches and is given off horizontally, with a slight inclination upwards. The occipital condyles, the styloids, and tympanic bullæ are entire on both sides, together with the auditory foramina and the whole of the basi-sphenoid region. The right side of the vertex and the upper part of the frontal, together with the right orbit, are gone. Part of the left orbit remains. The plane of the frontal exhibits the same general form as in specimen No. 33, and the vertex projects posteriorly, overarching the occipital exactly as in that specimen. Length of fragment from vertex to anterior fracture, $6\frac{1}{2}$ inches; width of forehead at constriction behind the orbits, $6\frac{1}{2}$ inches; long diameter, 2·6 inches; short diameter, 2·3 inches; extreme distance between the outer border of the two occipital condyles, 3·6 inches. The core is cylindrical in section, like specimen No. 31, being a little flattened in front and more convex behind. This specimen would appear to afford further proofs of the inference derived from 31 and 33, as to the distinctness specifically of *Bos Namadicus*.

No. 35. *Bos* —— ?—Specimen consisting of facial part of the cranium from the orbits, exhibiting the maxillaries on both sides with the entire line of molars *in situ*, the posterior part of the diastema and a portion of the nasals; the intermaxillaries broken off. This specimen is exactly in the same mineral condition, with a ferruginous tinge, as the cranium No. 20.

Dimensions.—Length of the molar series, right side, $5\frac{3}{4}$ inches; distance between the outer surfaces of the molars at the middle of the series, $4\frac{3}{4}$ inches; width of palate taken at the rear of the last molar, 3 inches; ditto in the middle, 3·25 inches; ditto between anterior molars, 3 inches. The molars on the right side are quite entire, they are all protruded and well worn. Species indeterminable without more detailed comparison.

[1] *Vide* Dr. Spilsbury in Journ. As. Soc. xiii. 765, Pl. ii. fig. 3 *c*.

No. 36. *Bos* —— ?—Fragment comprising facial part of cranium, like 35, but crushed laterally, presenting the two maxillaries with the whole series of molars in each. Nasals broken off by a fresh fracture near commencement of diastema. The palate is broken from the crushing, and the opposite lines of molars are at unequal heights. Length of left molar series, 5·9. The molars are all protruded and in the same state of wearing as in No. 35. The specimen is encrusted with an argillaceous matrix.

No. 41. *Bos Namadicus.*—Fine specimen of cranium, nearly entire, exhibiting the whole of the chevron region from near the vertex on the right side, as far as the extremity of the nasals, which are broken off at their tips; also all the maxillary portion of the diastema, with a portion of the right incisive; the two orbits nearly entire; the two zygomatic arches and temporal fossæ; the four back molars on the right side, and the five front molars on the left side, all protruded and worn so as to show that the animal was fully adult but not aged. Also the whole of the lower surface of the cranium, from the diastema back along the palate and spheno-palate region on to the occipital foramen. The basi-sphenoid protuberances, occipital condyles, foramen magnum, tympanic bullæ, and glenoid cavity perfectly entire, with the auditory foramen, right side, partially shown. Also the posterior and basal portion of the occipital entire.

Deficient only at the vertex, which is broken off obliquely from the right angle downwards and forwards to the left, the fracture having removed the left side of the occipital plane, the whole of the occipital crest, and the cores of the two horns. On the left side the fracture encroaches upon the plane of the frontal, but on the right the base of the core of horn is *in situ*, broken off vertically in a line with the supra-auditory apophysis at the root of the jugum. Truncated in front about the middle of the incisives; the supra- and infra-orbital foramen present on both sides. In all other respects the specimen is singularly perfect, with the exception of the inferior border of the right orbit, which is abraded. The form of the cranium in this specimen differs very notably from that of the Gour and Gayal and other bisontine forms, recent or fossil, in its much greater elongation as compared with the width, in the lesser prominence of the orbital margin, and in the more slender proportions of the whole of the facial and muzzle regions. In these respects it exhibits a considerable resemblance to the taurine division of Bos as represented by *Bos primigenius*. This is well shown in the form of the construction between the base of the horn-cores and orbits, which is in a long curve. From Jahnsee Ghat on the Nerbudda.[1]

Extreme length of specimen, 18 inches; from the broken margin of vertex to commencement of the diastema, 16 inches; from ditto to upper border of orbit, $6\frac{1}{2}$ inches; antero-posterior diameter of orbit, 3·3 inches; transverse ditto, 2·5 inches; length from anterior border of orbit to commencement of diastema, 7·3 inches; length from broken border of vertex to the naso-lachrymal termination of the frontal, 10·5. Length of truncated portion of muzzle in front of molars, 2·2 inches;

[1] *Vide* Jour. As. Soc. Beng. viii. 951.

length of line of molars, left side, 6·1 inches; width of frontal at constriction behind the orbits, 7·1 inches; ditto between the outer borders of the orbits, 9· inches; height from surface of occipital condyle to plane of frontal at vertex, 6·4 inches; length of nasals to commencement of incisive bone, 7·2 inches; width of face immediately in front of orbits, 6·2 inches; ditto at the maxillary tuberosities, 5·9 inches; ditto at commencement of diastema, 3·4 inches.

Interval between outer margin of zygomatic arches, 8·2 inches; interval between external surface of maxillaries at the rear of the back molar, 4·7 inches; ditto, at commencement of penultimate molar, 5·3 inches; interval between inside of back molars, 3·1 inches; ditto, between the penultimate molars, 3·2 inches; ditto, in front between the two premolars, 2·9; width between the diastemal ridges of the maxillaries, 1·5 inch; from anterior border of orbit to infra-orbital foramen, 6·2 inches.

The interfrontal suture is distinctly shown, also the transfrontal and the other sutures of the face.

From the description and dimensions above given, the cranium is considered to indicate a distinct species of Bos and to agree with the specimens Nos. 32, 34, and 35, and to be a female. The general form presents many analogies with the cranium of *Bos primigenius* figured in Owen's Brit. Fossil Mammalia, fig. 208, page 498, and with the crania figured in the Ossemens Fossiles, Pl. CLXXII., figs. 1 and 2.

No. 47. *Bos Namadicus?*—Fragment of cranium, very much mutilated, showing only occiput with occipital condyles, foramen magnum, and right mastoid process, with a nest of calcareous crystals occupying the cranial cavity and the cancelli of the hollow vertex. This must have belonged to an animal of very large size. Query? Did the huge horn-core No. 31 belong to this cranium?

III.—Description by Dr. Falconer of Fossil Remains of Antelope, from the Sewalik Hills, in the Museum of the Asiatic Society of Bengal.

No. 569. *Antilope.*—Fragment of skull, comprising the whole of the cranial portion nearly entire with the occipital and parietal regions, right orbit, and the bases of two horn-cores, that on the left side 1½ in. long. The animal was of a size between the Nylghau and the *Antilope cervicapra*; the frontal on either side shows a prominent ridge from the base of the horn towards the occiput as in the Nylghau; the frontals are too much mutilated to show whether there are ridges in front of the horn. The horn-cores are cylindrical and appear to start from the brow as in *Antilope cervicapra*; tympanic bullæ large.

No. 573. *Antilope.*—Fragment of cranium of an antelope, comprising the left frontal detached, with a thick cylindrical horn-core attached, and showing a part of the cup of the left orbit. It corresponds very closely in size and appearance with 569, and probably belonged to the same species which is considerably larger than *Antilope cervicapra.*

No appearance of a spiral twist in the core of the horn as in that group of antelopes.

	Inches
Length of horn-core	4·5
Antero-posterior diameter	1·7
Transverse ditto	1·6

From near Nahun.

No. 581. *Antilope Palæindica.*—Fine crânium of an antelope, comprising two horn-cores, both orbits and the facial portion as far as the diasteme with the line of molars on either side; the specimen is at once distinguished by the close approximation of the horn-cores, by the sudden inclination which the posterior part of the frontal makes with the nasal plane in a line with the middle of the orbits, and by the deep lachrymal fossæ in front of the orbits. The specimen agrees most closely in form and proportion with that figured at vol. xii. Journ. As. Soc. p. 770, figs. 1 and 2, described by Captain Baker. The horns diverge slightly and at the same time curve backwards and outwards. The species differs very remarkably in form from any Asiatic antelope known, and Captain Baker compares it to the Sassaybe or *Acronotus lunatus.* It is considerably larger than *Antilope cervicapra*—more nearly approaching the size of the Nylghau. Occipital and sphenoidal regions entirely wanting. Molar teeth devoid of any accessory pillar between the barrels.

	Inches
Length of fragment from behind the horn-cores to commencement of diasteme	10·
Length of right horn-core fragment	3·
Interval between cores at base	0·5
Ditto at two inches height	0·8
Antero-posterior diameter of orbit	2·3
Length of line of molars	3·9
Height from alveolar border to middle of nasals	4·2

The supra-orbital fossæ are very deep and marked, as in the *Antilope cervicapra* and as shown in Captain Baker's figure, although otherwise described in his paper. The supra-orbital foramina are very much smaller than in that species. (*Vide* Plate XXIII.)

No. 582. *Antilope Palæindica.*—Another specimen very like the last, but more perfect, contained in a mass of matrix enveloping a great number of bones of different animals in all directions, among others apparently the metatarsal extremity of a Sivatherium. The right horn-core is of considerably greater length than in No. 581, and diverges outwards exactly as in Captain Baker's drawing; orbits, zygomatic arches and molars on both sides are present, but covered with matrix.

IV.—Descriptions by Captain Baker of Fossil Antelope of Sewalik Hills. (Antilope Palæindica of Falconer.)

1. *From Journ. As. Soc. for Oct.*, 1835, *vol. iv. p.* 569.

Figs. 40, 41, and 42 are different views of a skull of an animal allied to the Antelope; the length and narrowness of the face, the height of the nose, and the peculiar setting on of the horns are all more conspicuously exemplified in another specimen of a similar skull, which Colonel

DESCRIPTION OF PLATE XXIII.

ANTILOPE PALÆINDICA.

Figs. 1, 2, and 3. Three different views of cranium of *Antilope Palæindica*, drawn by Mr. Dinkel from the original in the British Museum (Cat. No. 39,594). About one-fourth of the natural size. (See pages 290 & 555.)

Fig. 1.

Fig. 2.

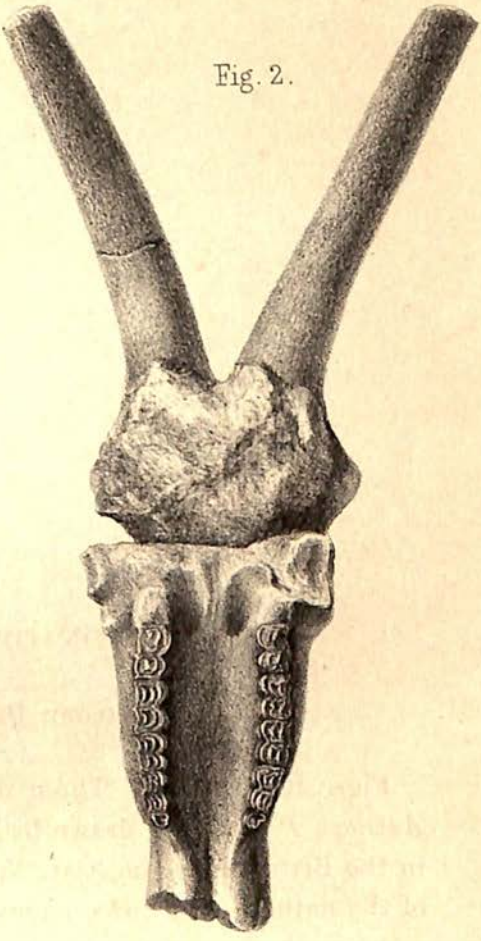
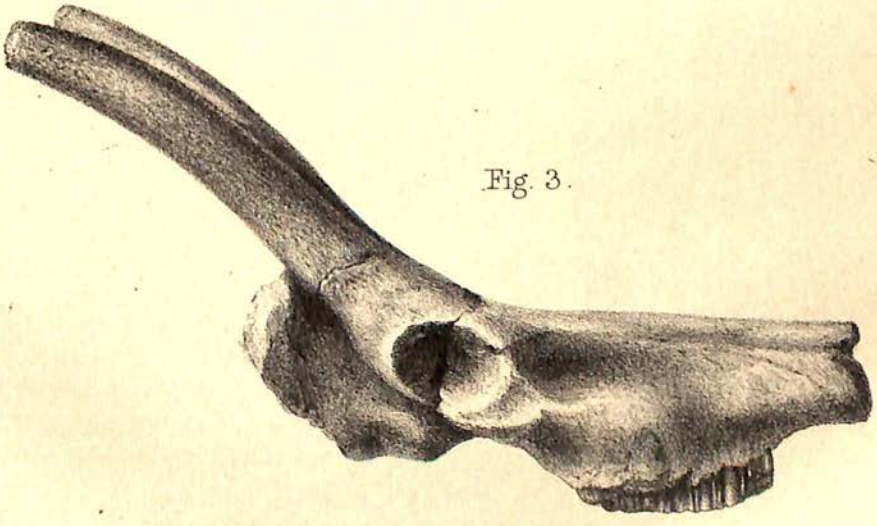


Fig. 3.



Antilope Palæindica.

J. Dinkel del. et lith

W. West imp.

Colvin purposes presenting to the Asiatic Society. Our specimen, however, has the advantage of possessing the cranium and occiput entire.

2. *From Journ. As. Soc. for* 1843, *vol. xii. p.* 770.

The Fossil differs from the Indian Antelope, in the greater elongation of its face, the straightness of its profile, the close juxta-position of its horns at the base, the absence or small development of the infra-orbital sinus, and the small size of the supra-orbital foramina. In all these respects it resembles one or other of the African genera, from the descriptions of which, by Captain Harris, I have extracted the following:—

'*Acronotus caama*, or *Hartebeest*.—Head remarkably heavy, narrow, and long. Horns seated upon the summit of a beetling ridge above the frontals; very close together and almost touching at the base. No sub-orbital sinus.'

'*Acronotus lunatus*, or *Sassaybe*.—Head long, narrow, and shapeless, wearing a bubaline appearance; facial line straight; eyes high in the cranium; indistinct lachrymal perforation.'

As far, therefore, as can be judged from a description, which, like the above, has no particular reference to the osteology of these animals, they appear to have a considerable resemblance to our Fossil. [This specimen of Captain Baker's is now in the British Museum (No. 39,594), and is represented in Plate XXIII.—Ed.]

XIV. ON THE FOSSIL QUADRUMANA OF THE SEWALIK HILLS.

I.—Notice on the Remains of a Fossil Monkey from the Tertiary Strata of the Sewalik Hills in the North of Hindostan.[1]

BY CAPTAIN P. T. CAUTLEY, F.G.S., AND H. FALCONER, M.D.

(*Dated November 24th, 1836: read June 14th, 1837.*)

The most highly organized mammifers hitherto described in a fossil state, so far as our information extends, have belonged to the *Cheiroptera*; and the instances of these on record are very few.[2] That quadrumanous remains should be wanting is by no means surprising, without the necessity of supposing that they did not exist. The countries of which the ancient races have been most completely investigated, had a climate unsuited to be the habitat of the tribe, as we now know it, when the more recent or superficial deposits were in progress of formation. If we refer to the remote epochs when the climate was suitable, and when genera now associated with the Monkeys were abundant, it is easy to conceive that the latter might have existed in numbers, without their remains being entombed. It requires, in all instances, many unconnected circumstances for the preservation of organic bodies, and their subsequent disclosure. Amongst the most important of these are the habits and organization of the animals themselves. As in the case of birds, it might be predicated that this lucky concurrence of circumstances would be rare with quadrumanous remains. The very perfection in the organization of the Monkey entails, as a consequence, that his solid frame should seldom continue to indicate the previous existence of the individual. His admirable agility and social habits protect him against most aggressions. A flood might suffocate in their dens, over a large tract of country, the burrowing tribes; it might sweep from under the feet of the monkey, hundreds of its herbivorous and predaceous fellow-tenants of the forest, and bury them in the near shingle or far distant estuary, or drown and deposit them in the stag-

[1] This memoir is reprinted from the Transactions of the Geol. Soc. of London, vol. v. 2nd series, p. 499. The astragalus described was presented to the Museum of the Society.—[Ed.]

[2] Brewster's Edinburgh Journal of Science.

nant swamp—while he would remain secure. The tree on which he was perched might totter, and yield to the undermining current, and he still escape and feed on his wonted fruits, undisturbed by the destruction around. When the debt of nature comes to be paid, his carcase falls to the ground, and immediately becomes the prey of the numerous predaceous scavengers of torrid regions, the Hyæna, the Chacal, and the Wolf. So speedily does this occur, that in India, where Monkeys occupy, in large societies, mango groves around villages, unmolested and cherished by man, the traces of casualties among them are so rarely seen, that the simple Hindoo believes that they bury their dead by night.

When the ancient races of India began to open upon us in the new forms and the exuberant variety which the fossils of the Sewalik hills exhibit, we were early led to anticipate that some trace of quadrumanous animals would soon be met with to perfect a series, which would be incomplete without them. Several months ago we became possessed of a solitary specimen, which put the matter, in our own minds, beyond all doubt. We deferred making it public, however, in the hope of soon finding specimens of the cranium and teeth; being unwilling to rest the announcement on anything less characteristic. That chance has since fallen to our fellow-labourers in the pursuit, Messrs. Baker and Durand, of the Bengal Engineers, who have lately discovered a specimen, consisting of a considerable portion of the face, and the whole series of molars of one side, of a quadrumanous animal belonging to a much larger species than the bone we found.

Our fossil is the specimen which accompanies this communication. It is the astragalus of a right hind leg. It is completely mineralized, having a specific gravity of about 2·8, and it appears to be impregnated with hydrate of iron. Although but a solitary bone of the foot, the relations of structure are so fixed that the identity of the fossil is as certain as if the entire skeleton were before us. The very shallow excavation of the superior surface (A in figs. 6 and 7) for the pulley-like articulation with the tibia; the form and extent of the lateral articulating surfaces (B, C, figs. 6, 7, 8, and 9) for the external and internal malleoli; the considerable elongation of the apophysis for the head and neck of the bone (G, H); the slight obliquity with which it is sent off from the body; and the diagonal direction and form of the principal articulating surface (D) with the calcaneum, are characters which, taken in conjunction, incontestably prove that the fossil is a quadrumanous astragalus. It would be needless, therefore, to dwell on the points of difference between it and the astragali of those orders of Mammalia which have an allied form. It is only requisite to ascertain how it agrees with the corres-

ponding bone in existing species of Quadrumana. It closely resembles, in size and general form, the astragalus of the *Semnopithecus entellus*, which we send along with the fossil for comparison.

The principal dimensions are as follows:—

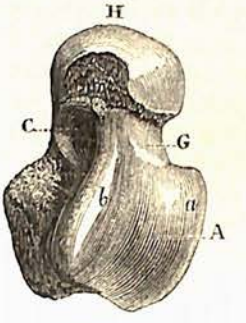
Dimensions.

	Sewalik Fossil Monkey	Semnopithecus entellus
Extreme length of astragalus	1·3 inch.	1·35 inch.
Extreme width of body of astragalus	1· „	1·03 „
Length of body	0·8 „	0·85 „
Greatest diameter of navicular head	0·65 „	0·65 „
Thickness of ditto	0·45 „	0·5 „

FIG. 6.

FOSSIL.

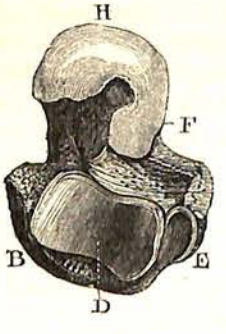
FIG. 7.



RECENT.

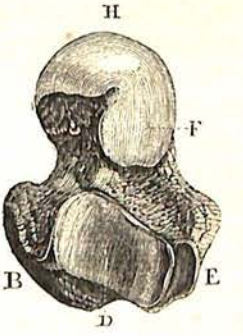
The chief peculiarities of the fossil astragalus, compared with that of the *Entellus*, are these:—The upper articulating surface for the tibia (A) is more convex than in the *Entellus*, and less square in the outline, the lateral margins (*a*, *b*) approximating

FIG. 8.



FOSSIL.

FIG. 9.



RECENT.

as they run backwards; the outer one being also more elevated. The peroneal articulation (B) is precisely of the same form and extent as in the *Entellus*; and the rough fossa between it and the large calcanean surface (D) also corresponds.

The articular surface (C) for the inner malleolus somewhat differs: in the fossil it is long, shallow, and rather pyriform in outline, while in the *Entellus* it is cup-shaped, deeper, and more extensive. The other pits and inequalities of the inner side correspond; but the entire surface slopes off more obliquely in the fossil. The great calcanean surface (D) has the same diagonal direction, with reference to the upper surface, as in the *Entellus*; it has also the same form, but it is more vaulted, and has less stretch and width. Its inner margin is bounded by the shallow, pulley-shaped fossa (E) for the tendon of the *flexor pollicis longus* muscle, entirely as in the *Entellus*; and the rough pit between it and the anterior calcanean surface (F) is alike in both. The head-and-neck apophysis is sent off as in the *Entellus*. The upper surface of the neck (G) is narrower and less sloped. The scaphoid surface of the head (H) is altogether less extensive. The head itself is not so thick and massive, and its long direction slopes more obliquely upwards than in the *Entellus*; its inferior articular surface is less, and there is a wide, rectagonal, rough gutter or fossa running half way across so as to make two surfaces. In the *Entellus* the fossa is obsolete and only indicated by a minute foramen, so that these articular surfaces run into one. This is the greatest difference observable in the fossil. The rough fossa at the outer side of the neck is alike in both.

With these inconsiderable peculiarities, the fossil agrees so closely in size and general form with the astragalus of the *Entellus*, that it probably belonged to the same sub-genus; still the points of difference are sufficient to leave no doubt, that the fossil must be assigned to a distinct species. In equalling the *Entellus*, it would belong to the larger Quadrumana. This is all the information the specimen conveys, regarding the animal from which it came; but we may hope to meet with remains, which will develope its entire osteology, more especially that of the cranium and face. The fossil was found by a party of Hindoo collectors employed by us on the fossil tract of the Sewalik hills; and was brought to us mixed up with a promiscuous collection of the remains of the Hippopotamus, Mastodon, Ruminants, &c., like the specimens which have been sent to the Society. We have not therefore the means of knowing the exact locality where, and the circumstances under which, it was found.

The discovery is interesting in itself as supplying a deficient link in the series of the former tenants of the globe, but greatly more so in connection with the races with which the fossil was associated. We have excavated from, or found in the débris of, different beds of the same formation which yielded the fossil astragalus, the remains of a species of

Anoplotherium,[1] the *Crocodilus biporcatus* and *C.* (*Leptorhynchus*) *Gangeticus*,[2] respectively the Magar and Gavial, two species which at the present day inhabit the quiet waters of the Ganges. Here then are two most instructive facts: Quadrumana co-existed with a member of the oldest ascertained pachydermatous genus of Europe; and two reptiles now the contemporaries of man in the East, lived, and may have laved, in the same waters along with a species of one of the mammiferous genera which characterize the Eocene period of the West; affording another illustration of constancy in the order of nature, of an identity of condition in the earth of the olden time with what it exhibits now, and of the invariableness of organized forms. The two decurrent ridges on the face which specifically distinguish the *C. biporcatus* of the present day are as marked and distinct on the individuals which existed perhaps centuries of centuries ago; and an ankle bone of the Sewalik fossil Monkey so closely resembles that of a living species, that it is difficult to explain the difference.

The Sewalik fossils abound in monuments of this sort. There is a mixture of the new and of the old, of the past and of the present, of familiar with surprising forms, together with a numerical richness, such as no other explored region has exhibited within so comparatively limited a space. The Camel,[3] the Antelope, and Anoplotherium, have been found, intermixed with each other in the *same bed*. There are remains of the Elephant, Mastodon, Hippopotamus,[4] Anthracotherium, Rhinoceros,[5] Hog, and Horse; the Tapir alone of the large existing Pachydermata being without a representative. In the Sivatherium[6] is seen a huge Ruminant exceeding in size the largest Rhinoceros; it is also armed with four enormous sheathed horns, divided and foliated like the Dicranocerine Antelopes, and able to contend for mastery with the Mastodon. Contrasted with him in the same family is the puny Musk Deer, scarcely larger than a Hare. There

[1] *Anoplotherium Sivalense*, a new species, of a size somewhat larger than the *A. commune* of the Paris basin. The species is known to us by two upper jaws in our possession with the series of molars complete. We therefore quote it unhesitatingly. (See *antea*, pp. 190 and 208.—Ed.)

[2] Known to us by specimens comprising the whole of the cranium and muzzle. They do not differ more from the existing individuals than these do from one another in varieties dependent on age and sex. Asiatic Researches, vol. xix. Part II., Art. II. (See Appendix to Memoir on Crocodile.—Ed.)

[3] *Camelus Sivalensis* (Nob.), Asiatic Researches, vol. xix. Part II., Art. X., a species of the size of the existing Camel. (See *antea*, p. 227.—Ed.)

[4] Asiat. Res., Art. III. *Hippopotamus Sivalensis* (Nob.), & *H. dissimilis* (Nob.). (See *antea*, p. 130.—Ed.)

[5] Journal of the Asiatic Society, vol. iv. p. 706, and vol. v. p. 486. (See *antea*, p. 157.—Ed.)

[6] Asiat. Research *ut supra*, Art. I. *Sivatherium giganteum* (Nob.). Since the memoir was printed, Col. Colvin, Bengal Engineers, has got a specimen of the cranium with the bases of the four horns attached, and we have in our possession an almost entire rear horn, which has given the characters noted above. (See *antea*, p. 268.—Ed.)

are the Cat[1] and the Dog tribe, the Hyæna, Bear,[2] and Ratel,[3] and other Carnivora. In the feathered races there are Grallæ, greatly surpassing in size the gigantic Crane of Bengal (*Ciconia argala*). Among the Reptilia, besides the Magar and Gavial, there were other Crocodiles[4] of enormous bulk, approaching the largest Saurians; and the Testudinata, which have hitherto held but a humble rank beside their Saurian co-ordinals, here show their giant representatives. In addition to numerous species of Emys and Trionyx not bigger than the small Terrapins of the sluggish brooks of Hindostan, we possess humeri and femora of this tribe (with corresponding fragments of the bucklers) as large as the equivalent bones of the Indian Rhinoceros. As the Pterodactyle more than realized the most extravagant idea of the Winged Dragon, so does this huge Tortoise come up to the lofty conceptions of Hindoo mythology; and could we but recall the monsters to life, it were not difficult to imagine an Elephant supported on its back.

Suharunpoor: *Nov.* 24, 1836.

[1] Asiat. Res., Art XI. *Felis cristata* (Nob.). Smaller than the Tiger. (See *postea*, p. 315.—Ed.)

[2] *Ibid.* Art. XII. *Ursus Sivalensis* (Nob). Size of the *U. spelæus*. (See *postea*, p. 321.—Ed.)

[3] Messrs. Baker and Durand, Journ. Asiatic Society, vol. v. p. 581.

[4] *C. Leptorhynchus crassidens* (Nob.), an immense species far exceeding existing ones, and forming a passage from the Gavials into the true Crocodiles. It has the cylindrical muzzle and synostorized lower jaw of the former with the blunt thick teeth of the latter.

Fig. 10.

FROM A SKETCH IN PENCIL IN ONE OF DR. FALCONER'S NOTE-BOOKS BY THE LATE PROFESSOR EDWARD FORBES.

II.—Sub-Himalayan Fossil Remains of the Dadoopoor Collection.[1]

BY LIEUTS. W. E. BAKER AND H. M. DURAND.

Quadrumana.

Lyell, when combating the inconclusive evidence advanced in support of the theory of the progressive development of organic life, notices the absence of remains of quadrumanous species in a fossil state, and the hypothesis which this circumstance has by some geologists been considered to countenance. He, however, draws attention to the fact, that the animals which are found in sub-aqueous deposits are in general such as frequent marshes, rivers, or the borders of lakes, and that such as live in trees are very rarely discovered; he adds, moreover, that considerable progress must be made in ascertaining the contemporary pachydermata, before it can be anticipated that skeletons of the quadrumanous tribes should occur. Considering the great number of relics assignable to the *Pachydermata*, *Ruminantia*, and *Feræ*, which the Sub-Himalayan field has produced, it is not therefore surprising that at length the half jaw of a quadrumanous animal should be brought to light. The circumstance being interesting in several respects, we have not deferred its communication until further research should put us in possession of more perfect specimens; the chances are against the probability of more being brought in for some time. In the interval it may be as well at once to add to the Sub-Himalayan list of fossils one species belonging to the order of the *Quadrumana*.

The specimen in question was found in the hills near to the Sutlej, and it appears from the attached matrix to have been derived from a stratum very similar in composition to the one described as occurring at the Moginund deposit. The fragment consists of the right half of an upper jaw; the molars as to number are complete; but the first has lost some of its exterior enamel: and the fifth has likewise had a portion of the enamel from its hind side chipped off. The second and third molars are a good deal worn, and the state of the fourth and fifth such as to indicate that the animal was perfectly adult. The canine is small, but much mutilated, its insertion into the jaw and its section being all that is distinct.

[1] Reprinted from the 'Journal of the Asiatic Society' for Nov. 1836. vol. v. p. 739.—[Ed.]

From the inspection of the molar teeth, the order to which the animal belonged is sufficiently evident; but there is enough of the orbit remaining to afford additional and very satisfactory proof. The lower part of the orbit and the start of the zygomatic arch being very distinct, would alone remove all doubt from the subject, the orbits of the *Quadrumana* being peculiar and not easily to be confounded with those of other animals.

On comparison with the delineations of the dentition of this order of animals given by F. Cuvier, the fossil bears some resemblance to the genus *Semnopithecus*; the section of the canine and the form and size of the false molars are very similar to the example taken by F. Cuvier from a head of the species *Maurus*, found in Java. Had the drawing been taken from the *Entellus*, a species which inhabits India, the comparison would in this instance have been more satisfactory; but the *Maurus* being chosen as the type, and no mention made of other difference except length of canines, the various species may be supposed to present no material departure from the type in form of molars. The third molar in the fossil is so much worn as not to admit of being compared with drawings from unworn teeth; the fourth is like that of the *Maurus*, but the fifth does not resemble the analogous molars of any of the existing species as represented by F. Cuvier, for the fossil tooth possesses a small interstitial point of enamel at the inner side, which does not appear to have place in any of those delineated. The incisors are absent, but the inter-maxillary is clearly distinguishable.

Were it not for the size of the canine and the fifth molar, the specimen presents some resemblance to the genus *Macacus*, given as the type of the genera *Macacus* and *Cynocephalus*. The smallness of the canine and the large size of the molars cause the fossil to approach more nearly to the *Semnopithecus* than to the *Macacus*; the difference is, however, great between the two, for the *Entellus* is said to attain the length of three and a half feet, whereas the length of the fossil animal, if the space occupied by the molars and their size be deemed sufficient ground for a conjecture, must have been equal to that of the *Pithecus satyrus*: the space taken up by the molars is 2·15 inches. This circumstance, and the differences before pointed out, clearly separate the fossil from the species belonging to the genera *Cynocephalus* or *Semnopithecus*. The specimen is imperfect, but it indicates the existence of a gigantic species of quadrumanous animals contemporaneously with the Pachydermata of the Sub-Himalayahs, and thus supplies what has hitherto been a desideratum in palæontology —proof of the existence, in a fossil state, of the type of

organization most nearly resembling that of man (*Vide* Plate XXIV. figs. 1 and 2).[1]

III.—On Additional Fossil Species of the Order Quadrumana from the Sewalik Hills.[2]

BY H. FALCONER, M.D., AND CAPTAIN P. T. CAUTLEY.

In the November number of the Journal, vol. v. p. 739, Messrs. Baker and Durand have announced, in the discovery of a quadrumanous animal, one of the most interesting results that has followed on the researches into the fossil remains of the Sewalik hills. The specimen which they have figured and described comprises the right half of the upper jaw, with the series of molars complete; and they infer that it belonged to a very large species. In the course of last rains we detected in our collection an astragalus, which we referred to a quadrumanous animal. The specimen is an entire bone, free from any matrix and in a fine state of preservation from having been partly mineralized with hydrate of iron. It corresponds exactly in size with the astragalus of the *Semnopithecus entellus* or *Langoor*, and the details of form are so much alike in both, that measurement by the callipers was required to ascertain the points of difference. We have forwarded the specimen with a notice to the Geological Society of London, after keeping it some months in reserve, having been diffident about resting the first announcement of fossil *Quadrumana* on anything less decisive than the cranium or teeth.

This astragalus, in conjunction with Messrs. Baker and Durand's specimen, satisfied us of the existence of at least two distinct fossil *Quadrumana* in the Sewalik hills. We have lately become possessed of several fragments, more or less perfect, belonging to the lower jaws of two species, both smaller than Messrs. Baker and Durand's fossil. These we shall now proceed to notice.

The principal specimen is represented in Plate XXIV. figs. 3 and 4. It consists of both sides of the lower jaw; a great portion of the right half is entire with the whole series of molars; the left half is broken off to the rear of the ante-

[1] The fossil described in this paper is now in the British Museum, and from it original drawings have been made by Mr. Dinkel for this reprint. The drawings accompanying the memoir, as it appeared in the 'Journal of the Asiatic Society,' were little more than rough outline sketches. The fossil is also figured by Royle in his 'Illustrations of the Botany of the Himalayahs.' Plate vi. fig. 2.—[Ed.]

[2] Reprinted from the 'Journal of the Asiatic Society' for May 1837, vol. vi. p. 354. The drawings accompanying the original paper being merely rough outline sketches, fresh drawings have been made by Mr. Dinkel from the specimens in the British Museum.—[Ed.]

DESCRIPTION OF PLATE XXIV.

QUADRUMANA.

The figures in this Plate represent all the fossil remains of *Quadrumana* from the Sewalik Hills, in the British Museum, drawn of the natural size from the originals by Mr. Dinkel.

Fig. 1. Upper jaw, right side, of the gigantic quadrumanous animal described by Messrs. Baker and Durand at page 298. (Cat. No. 37,157.)

Fig. 2. Palate view of same specimen, showing the crowns of six molars.

Fig. 3. Lower jaw of a smaller species closely resembling but larger than *Semnopithecus entellus*, described by Dr. Falconer at page 300. The whole series of molars is present on the right side. (Cat. No. 15,709.)

Figs. 5 and 6. Fragment of body of right side of the lower jaw of another species of Monkey, containing the four rear molars. Described by Dr. Falconer at page 302. (Cat. No. 15,710.)

Figs. 7 and 8. Another fragment (Cat. No. 15,711) of right side of lower jaw of a quadrumanous animal containing the last molar, which agrees exactly in size with the corresponding tooth in figs. 5 and 6. (See page 303.)

Fig. 1.

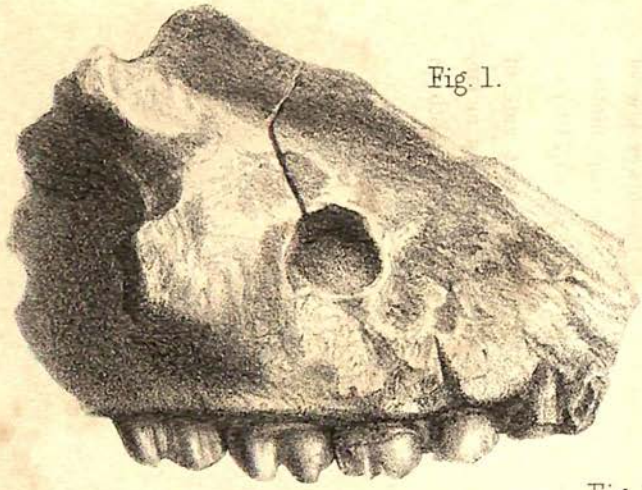


Fig. 3.

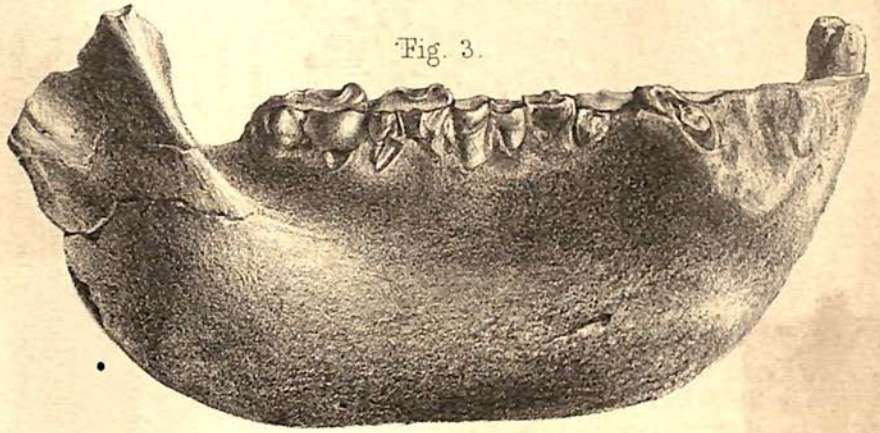


Fig. 8.

Fig. 7.

Fig. 5.

Fig. 6.

Fig. 2.

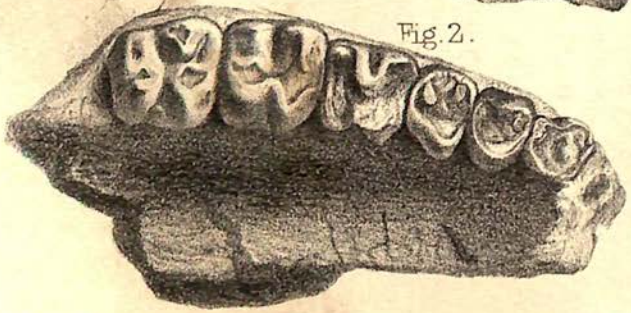
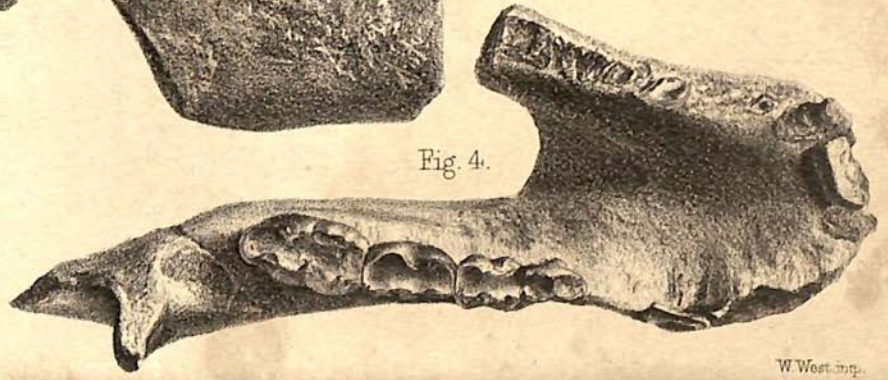


Fig. 4.



penultimate molar. The two middle incisors are present, and also the left canine broken across at its upper third. The right canine and the lateral incisors had dropt out, leaving only the alveoli. The molars of the left side are destroyed down to the level of the jaw. The right ramus is wanting in more than half its width, together with the articulating and coronoid processes, and a portion of the margin at the angle of the jaw is gone. The specimen is a black fossil, and strongly ferruginous; the specific gravity is about 2·70. It was encased in a matrix of hard sandstone, part of which is still left adhering to it.

The jaw had belonged to an extremely old animal. The last molar is worn down so as to have lost every trace of its points, and the three teeth in advance of it have been reduced to hollowed-out discs, encircled by the external plate of enamel. The muscular hollow on the ramus for the insertion of the temporal muscle is very marked, being ·35 inches deep with a width of ·55.

The dimensions contrasted with those of the *Langoor* or *Semnopithecus entellus* and the common Indian monkey or *Pithecus rhesus*, are as follows:—

Dimensions of the Lower Jaw	Fossil Sewalik Monkey	Semnopithecus entellus	Pethecus rhesus	Ratio of the Sewalik fossil to the Entellus
	Inches	Inches	Inches	
1. Extreme length from the anterior margin of the ramus to the middle incisors . . .	3·6	2·85	2·5	4 3·2
2. Extreme length of jaw (calculated in the fossil)	5·3	4·	3·6	4 3·02
3. Height of jaw under the 2nd molar measured to the margin of the alveoli	1·35	1·05	·85	4 3·1
4. Ditto at the rear molars . .	1·2	1·1	·95	4 3·6
5. Depth of symphysis . . .	1·9	1·4	1·1	4 3·
6. Space occupied by the molars .	2·3	1·9	1·5	4 3·3
7. Interval between the 1st molars .	·9	·75	·65	4 3·2
8. Antero-posterior diameter of the canine	·5	·4	·3	4 3·2
9. Width of jaw behind the chin under the 2nd molar . .	1·15	1·05	·95	4 3·7

As in all other tribes of animals in which the species are very numerous, and closely allied in organization, it is next to impossible to distinguish an individual species in the *Quadrumana* from a solitary bone. In the fossil, too, the effects of age have worn off those marks in the teeth, by which an approximation to the subgenus might be made. It very closely resembles the *Semnopithecus entellus* in form,

and comparative dimensions generally. The differences observable are slight. The symphysis is proportionally a little deeper than in *Entellus*, and the height of the body of the jaw somewhat greater. The chin, however, is considerably more compressed laterally under the second molar than in the *Entellus*, and the first molar is more elongated and salient. So much of the canine as remains has exactly the same form as in the *Entellus*, and its proportional size is fully as great. As shown by the dimensions, the jaw is much larger than in the full-grown *Entellus*; in the former the length would have been about 5·3 inches, while in the latter it is exactly 4 inches. The fossil was a species of smaller size than the animal to which the specimen described by Messrs. Baker and Durand belonged, but less so than it exceeds the *Entellus*.

Our limited means for comparison, restricted to two living species, besides the imperfection of the fossil and the few characters which it supplies, do not admit of affirming whether it belongs to an existing or extinct species; but the analogy of the ascertained number of extinct species among the Sewalik fossil mammalia makes it more probable that this monkey is an extinct one than otherwise. There is no doubt about its differing specifically from the two Indian species with which we have compared it.

The next specimen is shown in Plate XXIV. figs. 5 and 6. It is a fragment of the body of the right side of the lower jaw containing the four rear molars. The teeth are beautifully perfect. It had belonged to an adult although not an aged animal, the last molar having the points a little worn, while the anterior teeth are considerably so. The dimensions taken along with age at once prove that it belonged to a different and smaller species than the fossil first noticed.

The dimensions are as follows :—

Dimensions of the Lower Jaw	Smaller fossil Sewalik species	Larger fossil Sewalik species	Semnopithecus entellus	Pithecus rhesus
	Inches	Inches	Inches	
1. Length of space occupied by the four rear molars	1·48	1·7	1·48	1·25
2. Height of jaw at the third molar	·95		1·1	. ·9

The length of jaw, therefore, estimated from the space occupied by the teeth, would be 4 inches, while in the larger fossil it is 5·3 inches; a difference much too great to be dependent merely on varieties of one species. Besides, we have another fragment, also belonging to the right side of the

lower jaw, and containing the last molar, which agrees exactly in size with the corresponding tooth in the figured specimen. This goes to prove the size to have been constant. The fossil, although corresponding precisely in the space occupied by the four rear molars with the *Entellus*, has less height of jaw. There is further a difference in the teeth. In the *Entellus* the heel of the rear molar is a simple flattened obliquely surfaced tubercle, rather sharp at the inside. In the fossil, the heel in both fragments is bifid at the inside. The same structure is observable in the heel of the rear molar of the common Indian monkey, *P. rhesus*. It is therefore probable that the fossil was a *Pithecus* also. It was considerably larger, however, than the common monkey, and the jaw is more flattened, deeper, and its lower edge much sharper, than in the latter. This difference in size and form indicates the species to have been different.

It would appear, therefore, that there are three known species of fossil *Quadrumana* from the Sewalik hills: the first a very large species, discovered by Messrs. Baker and Durand; the second a large species also, but smaller than the first, and considerably larger than the *Entellus*; the third, of the size of the *Entellus*, and probably a *Pithecus*; and further, that two of the three at least, and most probably the third also, belonged to the types of the existing monkeys of the old Continent, in having but five molars, and not to the *Sapajous* of America.

There are at present upwards of 150 described species of existing *Quadrumana*; and as the three fossil ones all belonged to the larger sized monkeys, it is probable that there are several more Sewalik species to be discovered. We have some specimens of detached teeth, of large size, which we conjecture to be quadrumanous; but their detached state make this conjecture extremely doubtful.

Besides the interest attaching to the first discovery in the fossil state of animals so nearly approaching man in their organization as the *Quadrumana*, the fact is more especially interesting in the Sewalik species from the fossils with which they are associated. The same beds, or different beds of the same formation, from which the *Quadrumana* came, have yielded species of the camel and antelope, and the *Anoplotherium posterogenium* (Nob.):[1] the first two belonging to genera which are now coexistent with man, and the last to a genus characteristic of the oldest tertiary beds in Europe. The facts yielded by the Reptilian orders are still more interesting. Two of the fossil crocodiles of the Sewaliks are

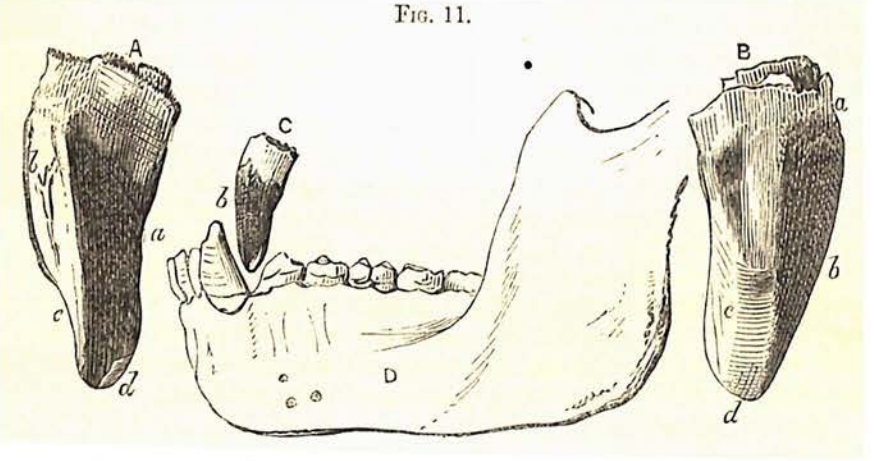
[1] *Chalicotherium Sivalense.*—[Ed.]

identical, without even ranging into varieties, with the *Crocodilus biporcatus*[1] and *Leptorynchus Gangeticus* which now inhabit in countless numbers the rivers of India; while the *Testudinata* are represented by the *Megalochelys Sivalensis* (Nob.),[2] a tortoise of enormous dimensions which holds in its order the same rank that the *Iguanodon* and *Megalosaurus* do among the *Saurians*. This huge reptile (the *Megalochelys*)—certainly the most remarkable of all the animals which the Sewaliks have yielded—from its size carries the imagination back to the era of gigantic Saurians. We have leg bones derived from it, with corresponding fragments of the shell, larger than the bones in the Indian unicorned Rhinoceros!

There is, therefore, in the Sewalik fossils, a mixture in the same formation of the types of all ages, from the existing up to that of the chalk; and all coexistent with *Quadrumana*.

P.S. Since the above remarks were put together, we have been led to analyze the character presented by a specimen in our collection which we had conjectured to be quadrumanous. The examination proves it to be so incontestably. The specimen is represented in fig. 11, A. and B.

FIG. 11.



A and B represent the canine of natural size; at C it has been reduced and placed in position with the lower jaw of the Sumatra Orang-Outang. (The drawing has been copied from one in the 'Journ. As. Soc.,' vol. vi. Pl. xviii.—ED.)

It is the extra-alveolar portion of the left canine of the upper jaw of a very large species. The identification rests upon two vertical facets of wear, one on the anterior surface, the other on the inner and posterior side, and the proof is this. The anterior facet *b* has been caused by the habitual abrasion of the upper canine against the rear surface of the lower one,

[1] *Crocodilus bombifrons.* See appendix to Memoir on Crocodiles.—[ED.]
[2] *Colossochelys Atlas.*—[ED.]

which overlaps it, when the jaws are closed or in action. This facet would prove nothing by itself, as it is common to all aged animals in the Carnivora and other tribes in which the upper and lower canines have their surfaces in contact. The second facet, *c*, *must* have been caused by the wear of the inner and rear surface of the canine against the outer surface of the first molar of the lower jaw. But to admit of such contact, this molar must have been contiguous with the lower canine without any blank space intervening; for if there was not this contiguity the upper canine could not touch the lower first molar, and consequently not wear against it. Now, this continuity of the series of molars and canines without a diasteme or blank interval is only found, throughout the whole animal kingdom,[1] in man, the *Quadrumana*, and the *Anoplotherium*. The fossil canine must therefore have belonged to one of these. It were needless to point out its difference from the human canine, which does not rise above the level of the molars. In all the species of *Anoplotherium* described by Cuvier, the canines, while in a contiguous series with the molars, do not project higher than these, being rudimentary as in man. Of the Sewalik species, *Anoplotherium posterogenium* (Nob.), we have not yet seen the canines;[2] but it is very improbable, and perhaps impossible, that the fossil could belong to it. For if this species had a salient canine, it must have been separated from the molars by an interval as in the other *Pachydermata*; otherwise the jaws would get locked by the canines and molars, and the lateral motion required by the structure of the teeth and the animal's herbivorous habit would be impracticable; and if there was this interval, the upper canine could not have the posterior facet of wear. The fossil canine must therefore have belonged to a quadrumanous animal. This inference is further borne out by the detrition of the fossil exactly corresponding with that of the canines of old monkeys.

The dimensions are:—

Length of the fragment of canine	1·75	inch.
Antero-posterior diameter at the base	·8	,,
Transverse ditto	·7	,,
Width of the anterior facet of wear	·6	,,

The two diameters are greater than those of the canine of the Sumatra Orang-outang described by Dr. Clarke Abel[3] as having been 7½ feet high. The *Cynocephali* have large and stout canines, more so comparatively than the other *Quadrumana*. But to what section of the tribe our fossil belonged,

[1] Cuvier, Oss. Foss., tome iii. p. 15.

[2] It had no canines, see *antea*, p. 211.—[Ed.]

[3] Asiatic Researches, vol. xv. p. 498.

we have not a conjecture to offer. We may remark, however, that the tooth is not channeled on three sides at the base, as in the *Entellus*. Does the fossil belong to the same species as the jaw discovered by Messrs. Baker and Durand, or to a larger one?

Appended Note by Mr. Prinsep, Ed. Journ. As. Society.— We have sketched Dr. Falconer's highly curious fossil tooth in position with the lower jaw of the Sumatran Orang-outang from the Society's Museum (fig. 11). There is a third facet of wear at the lower extremity *d* which, on reference, we find Dr. Falconer attributes like *c* to attrition against the first molar, being observable, he says, in many aged animals. The worn surfaces *c* and *d* are uniformly polished, and have evidently originated from attrition against a tooth; but with regard to the principal facet *b*, we confess we have a degree of scepticism, which can only be removed by a certainty that the fossil had been seen extracted from the matrix. In the first place, the great extent of the worn surface and its perfect flatness could hardly be caused by attrition against the lower canine which should produce a curvature measured by the length of the jaw as radius. In the next place, the enamel of the tooth is less worn than the interior and softer part of the fossil; and thirdly, on examination with a magnifier, numerous scratches are visible in divers directions: all these indicating that the facet may have been produced *on the fossil*, by grinding it on a file or some hard flat surface. On showing the fossil to Madhusudana, the medical pandit of the Hindoo College, he at once pronounced that the tooth had been ground down to be used in medicine, being a sovereign specific in the native pharmacopœia. This circumstance need not necessarily affect the question, for it is probable that the native druggist would commence his rubbing on the natural plane, if any presented itself to his choice; but Dr. Falconer and Capt. Cautley, to whom we have returned the fossil with a communication of our doubts, assure us in reply that the fossil tooth was brought in along with a large collection, so that there is every improbability of its having been in possession of a native druggist. At any rate, it is not on the front wear that they so much rest their argument of its origin, as on the posterior abrasion which could only happen in the jaw of a quadrumanous animal. In fact, they have recent Quadrumana showing precisely similar wear on a small scale, and no other head will do so. We find only one exception in the Society's Museum, viz. the Tapir, whose right upper incisor (or non-salient canine) falling between the two lower ones is worn nearly in the fashion of the fossil, but it is less elongated.

[The following is an extract from a letter addressed by Mr. Prinsep to Dr. Falconer on April 7th, 1837:—'I have not only read your reasoning with attention, but have conferred with the best authorities here, and with the best of all, viz. the Orang-outang himself in our Museum, anent the quadrumanous canine tooth. The result is a firm conviction that you are right. Indeed the tooth fits so well on to the Orang that it might be thought (and has been!) to belong to this very individual.'

Five years afterwards, also, in 1842, Dr. Falconer instituted a close comparison between this tooth and the corresponding tooth of three skulls of the Orang-outang, contained in the Museum of the Asiatic Society in Calcutta, and found their agreement so close that he conjectured that the extinct Sewalik form had been a large ape allied to *Pithecus satyrus*. See vol. ii. 'Memoir on Antiquity of Man.'—Ed.]

IV.—On Additional Quadrumanous Remains from the Tertiary Deposits of the Sewalik Hills.[1]

BY H. FALCONER, M.D.

Last November we forwarded to Mr. Lonsdale for his acceptance a fossil astragalus of a quadrumanous animal, which we requested he would do us the favour of submitting to the Geological Society, along with a descriptive notice which accompanied the specimen. We intimated that Lieut. Baker, of the Bengal Engineers, had discovered a large portion of the face, comprising the series of molars, of a much larger species, also from the Sewalik hills; establishing the contemporaneous existence of at least two species of Quadrumana, along with both extinct and recent mammiferous genera, such as the Camel, Anoplotherium and Sivatherium, and also some existing species of Crocodiles. We expressed the hope that we should soon come to the possession of more quadrumanous remains from the tract which has hitherto yielded us so rich a harvest. This anticipation has already been realized.

In the 'Journal of the Asiatic Society' for May, 1837, we have figured and described several additional remains containing teeth, and one of them a nearly complete lower jaw, of fossil Quadrumana from the Sewalik hills. In a postscript to the paper we have noticed a remarkable fragment consisting of a detached canine, which we refer

[1] This paper was written in 1837, but was never sent, as intended, to the Geological Society, and is now for the first time published.—[Ed.]

to the same order. The specimen is herewith submitted to the Society. It belonged to the left side of the upper jaw. The evidence which would make it quadrumanous is briefly this: There are two surfaces of wear, the one a flat smooth disc on the anterior side, and the other a flexuous smooth surface on the posterior and inner side, with a slight oblique abrasion of enamel at the worn apex; the anterior wear occasioned by the play of the lower canine upon the upper, and the rear one, by the play of the posterior and inner surface of the upper canine against the outer surface of the first molar of the lower jaw. To produce this posterior wear two conditions in the jaw were necessary: first, the anterior molar of the lower jaw must have been quite close to its adjoining canine; and second, the upper canine must have projected above the level of the other teeth, so as to overlap the lower first molar; otherwise the wear could not take place. Now the first of these conditions is common to man, Quadrumana and the Anoplotherium, and with a very partial exception restricted among Mammalia to them; the second, among these three genera, is confined to the Quadrumana.

In some of the Carnivora, more especially in the Bear, in which the number of molars is very variable, sometimes the anterior false molar of the lower jaw is placed close to the canine, as in the *Ursus Tibetanus*, and then the upper canine may play slightly against it. But this tooth, under these circumstances, is very rudimentary, small, and single-fanged, and the utmost amount of its effect is to produce a slight vertical streak on the enamel of the canine, at its rear surface. The broad flat disc of wear which the fossil has on its anterior side we believe never occurs in the canines of Carnivora, while it does in monkeys. The exception does not, therefore, appear to invalidate the evidence that the fossil is quadrumanous.

It has been objected to us by a scientific friend, Mr. James Prinsep, to whom the specimen was sent to be examined and figured for the 'Journal of the Asiatic Society,' that the anterior surface is too extensive to have been naturally produced; that it bears the marks of artificial abrasion; and that, as we ourselves did not see it dug out of the matrix, it was probably ground down, as such teeth are highly prized as a medicine and charm, in certain parts of India.

On these objections we have to remark that the anterior wear is quite as great, and precisely similar in aged male monkeys, as is seen in the canine of a male Entellus, which accompanies the fossil; that the edge of enamel is elevated slightly above the flat disc of ivory, which could not be the case had the surface been artificially ground down; that the

streaks on the surface were probably caused by rubbing on a table in an attempt to remove a slight portion of the matrix, which still adheres to the middle of the disc; that in the neighbourhood of the Sewalik hills such fossil bones and teeth have no reputation either as medicines or charms, for amongst the enormous collections of bones and teeth that we have made in the tract we have not met with a single instance of a specimen having been ground down, or manipulated in any way for a charm or medicine; and that, although we did not see the specimen exhumed, nor do we even know the exact spot from which it came, yet we have no reason to suspect that it was ever in any other hands till got by our collectors. It was brought in mixed up in a large collection of other fossil bones.

If our inference be correct, it proves the existence of fossil Quadrumana in the Sewalik hills as large as the gigantic Orang-outang of Sumatra, described by Dr. Clarke Abel. The evidence usually supplied by organic remains is conclusive, from these remains being either *forms of structure*, such as bones, or *casts of forms*, such as coprolites, or the prints of birds' feet. In this case it is neither, but a secondary result or alteration of a form of structure, which generally proves nothing more than the age of an animal. But in the fossil it appears to us to be sufficiently good to be conclusive.

The inference is of considerable geological interest, and we hope, by sending the specimen to the Geological Society, that it may either be confirmed or refuted.

V.—Note on a Correction of Published Statements respecting Fossil Quadrumana.[1]

BY H. FALCONER, M.D., F.R.S., F.G.S.

Of the sciences which unite to build up the superstructure of geology there is none more rapid in its progress, or which contributes more to the enlargement of the pile, than Palæontology. Year after year brings forth with unerring certainty its complement of extinct forms, new to the system, or extends the area of what was but partially known before; while, at irregular intervals facts of such importance spring unexpectedly to light, that the science makes a bound in advance, and we are carried irresistibly onward by the impulse. Too often in such cases, elated by the result and fascinated by the prospects opened before us, we neglect to apply to the

[1] The paper of which this is a portion was written in 1862, less than three years before the author's death, but was never published.—[Ed.]

sudden stride the close and severe scrutiny which marks the ordinary progress of the science. We push on, taking it for granted that the steps which we have leaped over are secure, and that all is sound in our wake. But a lesson of wisdom, sooner or later, is certain to overtake us. Occasions arise which awaken us to a sense of insecurity, our confidence is shaken, and we are compelled to cast a searching glance behind us. The inexorable law which tracks every hurried and unsound result of human labour, material or intellectual, exacts reparation. What we have built up in haste we are compelled to throw down and reconstruct with care and attention. When assured that all is made right, we start again on our onward progress to achieve renewed success, sobered by the lesson of the past, and provided with safeguards for the future.

The same kind of retrospect which from time to time we cast on the material facts, justice demands of us to apply also to the history of discovery in the science. Facts which are now fused in the common mass may have exercised a powerful influence when first brought to light. The impartial historian will regard them in this light, and not merely as they now appear. He will also be scrupulously careful to award to the first observers fairly what is their due; for, apart from the abstract consideration of justice, the only guarantee which we have that our own labours shall be respected in the future is the fairness with which we ourselves deal with the labours of our contemporaries and of those who have gone before us.

These trite reflections are called up on the present occasion by what has lately come to light in regard to the discovery of fossil Quadrumana, and by the investigations now in progress respecting the early appearance of the human race upon the surface of the globe. Having had a humble share in both, and historical injustice having been, as I consider, done to me, though perhaps unwittingly, as regards the date of the former, I think the time appropriate for indicating an historical correction concerning the exact determination of supposed fossil Quadrumana.

When Cuvier died, monkeys and man were alike unknown in the fossil state, and the negative evidence furnished the great French anatomist with an argument, which he wielded with powerful effect and to the general acceptance of mankind, in favour of the very modern appearance of both upon the earth. But in 1836 and 1837 the successive discovery of fossil Quadrumana in miocene strata in India and Europe excited much interest, and communicated a hopeful forecast to the aspirations of Palæontology. Now, the subject is so

far advanced that the great problem of the day is, 'How far back in time are we justified in carrying the human race as contemporary with the extinct mammalia of the quaternary period?' The two subjects are intimately connected by many aspects, and the tendency of inquiry at the present time is to indicate that they will be still more closely connected by future research. The problem will doubtless be worked out with philosophic caution and scrupulous accuracy; but a lesson of prudence may be learnt from the quadrumanous past in reference to the spurious or unreliable evidence which the stimulus of a newly started and exciting subject is certain to bring forth.

I will now call attention to the historical correction.

In 1836, fossil Quadrumana were discovered in the Sewalik hills in India.

In February, 1837, Sir Charles Lyell, then president, in his anniversary address to the Geological Society, used the following terms with reference to the award of the Wollaston medals: 'Dr. Royle has permitted me to read part of their (Captain Cautley's and Dr. Falconer's) correspondence with him, when they were exploring the Sewalik mountains, and I can bear witness to their extraordinary energy and perseverance,' &c. (*op. cit.* p. 35). Dr. Royle was then one of the secretaries of the Geological Society; and on the 3rd May of the same year (1837), the following appears on the proceedings of the Society:—Read: 'An extract of a letter, dated Suharunpoor, 18th November, 1836, from Captain Cautley to Dr. Royle, was next read, permitting the announcement, *which had long been communicated to the latter*, of the finding of the remains of a quadrumanous animal in the Sewalik hills, or Sub-Himalayan range of mountains. An *astragalus* was *first* found, but latterly a nearly perfect head, with one side of the molars and one orbit nearly complete.'—*Proceedings*, p. 544).

On the 14th June, 1837, a memoir by Captain Cautley and Dr. Falconer, entitled, 'On Remains of a Fossil Monkey, from the tertiary strata of the Sewalik hills,' was read to the Geological Society. It bears date, Suharunpoor, 24th Nov., 1836, and it appeared in the 5th volume, second series, of the 'Geological Transactions,' carrying that date. The original fossil astragalus which it describes, together with the corresponding bone of the living *Semnopithecus entellus*, was transmitted along with the memoir; and both are now extant in the Museum of the Society.[1]

[1] Sir Proby Cautley informs me that for many months before this paper was despatched, Dr. Falconer always carried this astragalus in his pocket,

In explanation of the interval which elapsed between the date of communication by the authors and the date when the memoir was read to the Geological Society, it is to be remembered that the now quick means of transmission to and from India, by the overland route, did not at the time exist, and that the memoir and the objects were forwarded by the only channel then open, being the long voyage round the Cape.

Assuming the dates set forth to be authentic—and about this it is believed there can be no question—indubitable evidence is borne on two distinct publications of the Geological Society, that Captain Cautley and myself had established the existence of a fossil quadrumanous species in the strata of the Sewalik hills, upon materials discovered, identified, and described by ourselves, at least as far back as the 18th Nov., 1836. In fact, the specimen which belonged to my collection was identified by me in the shape in which it came before the Society, in the spring of 1836; but being unwilling to rest so important an announcement upon other materials than the skull or teeth, Dr. Royle, to whom the discovery was communicated, was requested to withhold it from publication. The fossil astragalus now before the meeting was, I believe, the first quadrumanous fossil remain determined by the eye of science. In affirming this, I do not mean to prefer any claim anterior to November, 1836; but this strong conviction in my mind will explain to the Society why I should not feel disposed tamely to brook the injustice, that the unreliable record of history should put me a full year back in the order of discovery.

The next incident of the case is an important paper by Captains Baker and Durand, on fossil quadrumanous remains from the Sewalik hills, which appeared in the number *for* the month of November, 1836, of the 'Journal of the Asiatic Society of Bengal.' There is no record borne on the Proceedings of the Asiatic Society when the memoir was communicated or received, nor is any date borne on the memoir itself. But it is manifest that the number of the journal in question was not published, or even printed, until after the 7th December, 1836, since it contains the record of the Pro-

and was thoroughly convinced of its quadrumanous nature, although with his characteristic caution he waited for further evidence before making the discovery public. The credit of the first discovery of fossil Quadrumana has generally been awarded to French naturalists (see Supplementary Notes to Dr. Buckland's Bridgewater Treatise); but the date of Falconer's first paper was two months antecedent to the presentation, on the 16th January 1837, to the French Academy of Sciences of a Memoir by M. Lartet, respecting the discovery of the lower jaw of an ape, in the tertiary freshwater formation of Simorre, in the south of France.—[Ed.]

ceedings of the meeting of the Asiatic Society held on that date. Messrs. Baker and Durand, although later in point of actual discovery, were before Captain Cautley and myself in publication, they having wisely availed themselves of the local scientific journal, while we forwarded our memoir to the Geological Society. Our friends, therefore, established a just claim to priority of publication, which we have never dreamt of questioning. It is not with them that we are at issue, but with the inexact historians of the case.

The 5th vol., second series, of the 'Geological Transactions,' contains a memoir by Captain Cautley, bearing upon the fossil remains of the Sewalik hills; it contains comments in a foot-note by the referee, and the index of the volume points out that they were contributed by Professor Owen.

Let us now examine the reputed history. In the first part of the 'British Fossil Mammalia,' published in 1844, the author gives an account of the occurrence of Quadrumana in the fossil state. He assigns the first discovered case to Lieutenants Baker and Durand, in 1836, and then goes on to state, that in the 'year following' Captain Cautley and myself discovered a considerable portion of a lower jaw containing teeth. 'Fragments of two other lower jaws and an entire astragalus were *subsequently* discovered by these gentlemen.' Professor Owen here omits any notice of our memoir of the 24th November, 1836, which appeared in the same 5th vol. of the 'Geological Transactions,' along with the other, which passed through his hands as referee, and bears annotations by him. He jumbles all our quadrumanous findings together, and the most important being the astragalus, which was first in date, he puts last.

Sir Charles Lyell gives an historical note in the 'Principles of Geology,' on the same subject, in these words:—'The first quadrumanous fossils discovered in India were observed in 1836 in the Sewalik hills, a lower range of the Himalayah Mountains, by Lieutenants Baker and Durand, by whom their osteological characters were determined (Journal of Asiatic Soc. of Bengal, vol. v. p. 739), and in the *year following* other fossils of the same class were brought to light and described by Captain Cautley and Dr. Falconer.' On this occasion the author quotes our memoir in the 'Journal of the Asiatic Society of Bengal,' vol. vi. p. 354, for May, 1837; but he makes no mention of the Astragalus Memoir of November, 1836, and the note bears internal evidence that in framing it he followed Professor Owen as his guide, instead of consulting the original authorities. Beyond this he is blameless, he not being a professed expert in mammalian Palæontology. But the combined high authority and

wide currency of his great work have contributed largely to propagate an injurious error.

With the countenance of two such names as Professor Owen and Sir Charles Lyell to the inaccurate statement, it is not to be wondered at that it should have become incorporated *in succum et sanguinem* with the reputed history of the science, as a fact, by systematic writers. Among others, I may cite Pictet, who, in his 'Palæontologie,' faithfully follows the author of the 'British Fossil Mammalia' in assigning to Captain Cautley and myself '*l'année suivante*,' i.e. 1837.

The facts of the case are so plain, that I do not think it necessary to urge them beyond a parallel illustration:—Suppose a registry to be established in London for the record of all births of British parentage within the Imperial dominions, home and colonial; let two births, of distinct parentage, take place, say in Calcutta, in the month of November, 1861; let one of them be gazetted on the spot in a local periodical, and let the other appear in the 'Times' as soon as possible, with authentic particulars, in the month of January, 1862. What should be said of the accuracy of the registrar who inserted in his record that the one birth had taken place a year after the other?

Eighteen years have passed since the statement first appeared, in 1844, in the 'British Fossil Mammalia,' during which period I have remained silent; and it may be thought that the right of redress has lapsed, through default, by the effluxion of time. I admit that every correction of the kind should be vindicated at once, in the interest of truth, irrespectively of other considerations; yet personal indifference to so palpable an inaccuracy, and constitutional aversion from the hispid walks of controversy, led me to disregard it. The matter would probably never have been noticed by me, had not immunity from correction led to further error in Professor Owen's work, entitled 'Palæontology,' the second edition of which appeared in 1861, and in which the following paragraph occurs in the part devoted to the fossil Quadrumana: 'Genus *Semnopithecus*.—To this genus belong the petrified jaws, teeth, and *astragalus*, from the older pliocene or miocene rocks of the Sub-Himalayan hills, near Sutlej, India, discovered in 1836 by Durand and Baker.' Thus, what we were the first to discover is not merely abstracted from us, but we are struck out of the record. It was full time, therefore, that I should step forward to vindicate the cause of truth.

* * *

XV. ON FELIS CRISTATA, A NEW FOSSIL TIGER FROM THE SEWALIK HILLS.[1]

BY HUGH FALCONER, M.D., AND CAPTAIN P. T. CAUTLEY.

To the large fossil species of the genus *Felis* hitherto described we are now enabled to add another, from the tertiary strata of the Sewalik hills, differing alike from the *F. spelæa* and *F. antiqua* of the 'Ossemens Fossiles,' and, so far as our means for comparison enable us to judge, from every known member of the genus.

The specimen from which we take our description is one of the most perfect that has up to this time been exhumed from the fossil tract. It was found at the foot of a sandstone cliff, partly encased in a hard stone matrix. It consists of a nearly entire head, deficient only in the temporal apophysis of the left zygomatic arch, and in a small portion of the sagittal crest. The incisors had dropped out, but the alveoli are sufficiently distinct to indicate their number and relative size. The cheek teeth are nearly entire, but the canines are broken off at their bases. The fragility of the specimen has deterred us from removing a portion of hard stony matrix which fills up the right zygomatic fossa, and conceals the base of the skull from the anterior margin of the occipital foramen on to the posterior border of the palatine bones.

Plate XXV. fig. 2, represents the head in profile, and shows the peculiarities of the fossil in the most striking light.

1st. The relative shortness of the facial portion of the head, from the post-orbital apophyses of the frontal to the border of the incisives, and the length of the cranial portion from the same point to the occipital crest; the dimensions being as 124 to 153. In this respect it differs from all existing species, in which, as exhibited by Cuvier,[2] the facial portion of the head exceeds the cranial, generally to a considerable extent.

[1] This paper is reprinted from the 'Asiatic Researches,' vol. xix. p. 135, 1836. Several specimens of the skull of *Felis cristata* are figured in an unpublished plate of the 'Fauna Antiqua Sivalensis' (see description of Plate K.), and from this the accompanying drawings have been copied.—[Ed.]

[2] Ossemens Fossiles, vol. iv. p. 147.

2nd. The outline of the upper surface of the cranium and face. The facial line runs with a gentle curve, slightly convex and nowise serpentine, to the rear of the post-orbital apophyses of the frontal. The cranial line meets it without angularity, and runs back horizontally to the occipital crest: so that when the head is seated on the occipital condyles and carnassier teeth, the plane of the base of the cranium is parallel to that of the vertex. In this respect it differs remarkably from all known large species of *Felis*, in which the cranial line descends more or less either in a curve or slope, from the post-orbital apophyses to the occipital crest.

3rd. The saliency of the sagittal crest, which greatly exceeds that of all known *Felinæ*. (See Plate XXV. fig. 1.)

4th. The height of the occipital, which is relatively greater than in any other known species of the genus (figs. 2 and 4).

5th. The elevated position of the zygomatic arches, and the strongly arched outline of their inferior margin.

Viewed from above (fig. 1), the contrasted proportions of the cranium and face are well exhibited. The muzzle is short. The canine region of the maxillaries swells greatly out in the bulge of the alveoli, and between it and the malars, the infra-orbital hollow is more abrupt and deeper than generally holds in the large *Felinæ*.* The nasals are short and broad. The brow is wide. The infra-orbital region of the frontal is marked by a deep longitudinal hollow. The post-orbital processes of the frontal and malars are blunt and little projecting. The post-orbital ridges of the frontal meet at a very acute angle, leaving between them a well-defined and narrow furrow. The length and prominence of the sagittal crest and the height of the occipital crest are strongly apparent. The parietals are seen to bulge out little towards their upper margin, but considerably towards the temporals.

Our means for comparison of the fossil with most of the large *Felinæ* are restricted to the figures in the 'Ossemens Fossiles,' which, however, are so perfect and characteristic as to admit of the chief marks of distinction being very readily seized. Of all the large species, the specimen most closely resembles the Tiger, although considerably smaller in size and perfectly distinct otherwise. The chief points of resemblance in both are the great development of the sagittal and occipital crests, the considerable surface of the occipital, the moderate convexity of the brow and face, and the elevated position of the zygomatic arches and the outline of their inferior margin. To exhibit the peculiarities of the fossil we shall now give its dimensions in juxta-position with those of two of the largest-sized Tigers, killed in the forests near Suharun-

DESCRIPTION OF PLATE XXV.

Felis cristata, Drepanodon Sivalensis, and Drepanodon latidens.

Fig. 1. Upper surface of cranium of *Felis cristata*, about two-sevenths of the natural size. The figure has been copied from a drawing by Mr. Ford in an unpublished Plate of the Fauna Antiqua Sivalensis. The specimen is in the British Museum (No. 37,133), and resembles that figured in the 'Asiatic Researches,' vol. xix. Plate XXI. (See pages 315 & 548.)

Fig. 2. Profile view of same specimen.

Fig. 3. Palate view of same specimen.

Fig. 4. Posterior view of same specimen, showing occipital condyles and foramen magnum.

Fig. 5. Fragment of upper jaw, right side, of *Drepanodon Sivalensis*, three-fourths of the natural size, and containing a portion of the canine, the posterior edge of which is finely serrated. The specimen is in the British Museum (No. 16,350), and the figure is copied from a drawing by Mr. Ford in an unpublished Plate of the Fauna Antiqua Sivalensis. (See page 550, and vol. ii. p. 456.)

Fig. 6. Fragment of lower jaw with three premolars of *Drepanodon Sivalensis*, three-fourths of the natural size The specimen is in the British Museum (No. 16,557), and is copied from a drawing by Mr. Ford in an unpublished Plate of the F. A. S. (See page 550.)

Figs. 7 and 8. Represent two views of a canine of the English *Drepanodon* (*Machairodus*) *latidens*. They have been reproduced from figs. 3 and 2 of Plate F of an unpublished work by the late Mr. McEnery on the fossil remains of Kent's Hole Cave, Torquay. The drawings are two-thirds of the natural size. McEnery's Plate has the following inscription:—'Teeth of *Ursus cultridens* found in the cave of Kent's Hole, near Torquay, Devon, by the Rev. Mr. McEnery, January, 1826, in diluvial mud, mixed with teeth and gnawed bones of Rhinoceros, Elephant, Horse, Ox, Elk, and Deer, and bones of Hyænas, Bears, Wolves, Foxes, &c.' (See vol. ii. p. 460.)

Fig. 2.

Fig. 1.

Fig. 3.

Fig. 5.

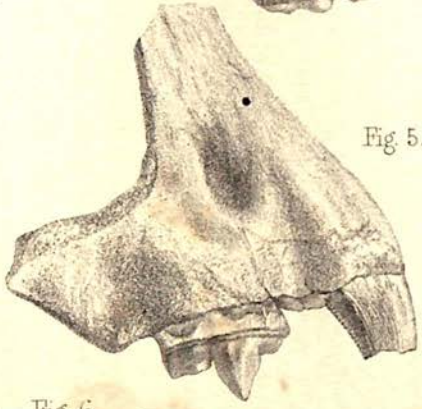
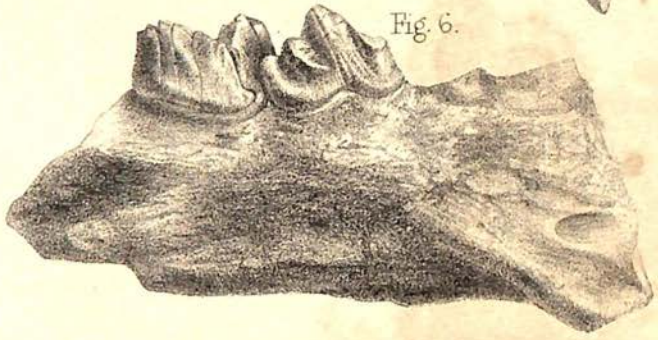


Fig. 6.



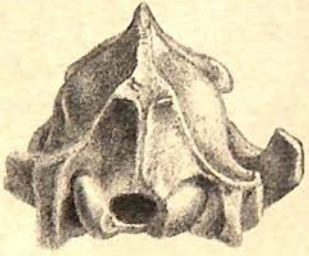


Fig. 4.

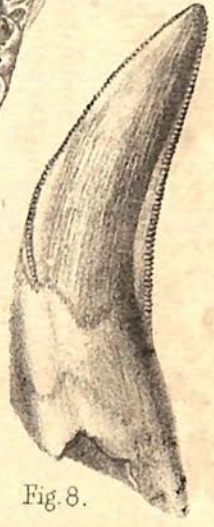


Fig. 8.

Fig. 7.

G.H. Ford del. J.Dinkel lith.

W.West imp.

poor, and of a younger animal almost exactly of the size of the fossil.[1] The amount of wearing in the cheek teeth and the condition of the sutures prove that the fossil was full-grown, although not aged.

	Fossil Tiger		Largest Tiger No. 1		Large Tiger No. 2	
	English Inches	French Mètre	English Inches	French Mètre	English Inches	French Mètre
1. Extreme length from occipital crest to alveoli of the incisors	10·9	·278	14·1	·358	13·1	·333
2. Ditto from anterior margin occipital foramen to ditto .	9·0	·228	11·7	·298	10·8	·274
3. Extreme breadth of head at zygomatic arches . .	8·0	·203	9·55	·242	10·0	·253
4. From posterior border of palate to the alveoli of the incisors	—	—	6·3	·180	5·9	·149
5. From anterior margin of nasals to occipital crest . .	9·2	·233	12·4	·314	11·85	·300
6. From border of post-orbital process to ditto . . .	6·0	·153	7·5	·191	7·0	·179
7. From ditto to the alveoli of incisors	4·9	·124	6·6	·168	6·1	·156
8. Extreme height from base of occipital foramen to occipital crest	4·1	·103	4·2	·106	4·2	·106
9. Width between outer surfaces of occipital condyles . .	2·2	·055	2·3	·058	2·45	·062
10. Ditto of occipital foramen .	—	—	1·15	·029	1·25	·031
11. Height of ditto	—	—	0·8	·020	0·8	·020
12. Height of cranium from middle of frontal to the palatine arch	—	—	4·6	·117	4·25	·108
13. Breadth on maxillaries between the canines and molars	3·0	·076	3·7	·093	3·5	·088
14. Extreme length of 2nd and 3rd molars	2·2	·055	2·32	·059	2·2	·056
15. Breadth of maxillaries to rear of carnassier . . .	4·5	·114	5·4	·138	5·6	·142
16. Depth of infra-orbital foramen	0·75	·018	0·7	·017	0·7	·017
17. Width of ditto . . .	0·3	·007	0·4	·010	0·375	·094
18. Length of the nasal bones .	2·8	·071	4·2	·106	4·1	·104
19. Length of carnassier tooth .	1·5	·038	1·4	·035	1·375	·034
20. Width of frontal between the post-orbital apophysis .	3·1	·078	4·2	·106	3·65	·092
21. Length from frontal angle to base of the nasals . .	2·9	·073	3·6	·090	2·9	·073

We shall now make a comparison of the peculiarities of the individual bones of the head with those of the Tiger. This will make the points of difference in the fossil more apparent.

The dentition of the fossil is as is normal in the genus. There are six alveoli for the incisors, the two outer of which

[1] The dimensions of this younger animal were omitted from the paper as originally published.—[Ed.]

are greatly larger than the intermediate, which are equal in size. The canines are broken off at their base; and the section is seen to be the same as in the Tiger. The cheek teeth had consisted of two false molars, a carnassier and a tuberculous tooth on either side. The tuberculous and the first false molar had dropped out. The socket of the tuberculous tooth is distinct on one side. Those of the first false molars are more ambiguous. In all the specimens of the *F. spelæa* observed by M. Goldfuss,[1] this false molar was invariably wanting, and he was induced to consider it as a specific distinction of the fossil. But Cuvier attributes its absence to dropping out at an early period.

In our fossil we were at first led to think that there was no small false molar, from the very contracted space between the canine and the large false molar not admitting of room for it. In the fossil the space is 0·3 inch, whereas in the Tiger it is 0·7 inch. But on carefully clearing the interval we have detected on the left side an alveolar cavity. In this respect, therefore, the fossil does not differ from the existing large species.[2] The great false molar and the carnassier tooth resemble in form those of the Tiger exactly. But they differ considerably in two respects, which we consider as distinctive marks of the fossil. First, The length of the two teeth in the fossil is exactly equal to that of the full-grown Tiger No. 2, although it measures 10·9 inches in length of head, while the Tiger is 13·1 inches; Second, The large false molar is directed inwards, so that its long axis makes a considerable angle with that of the carnassier. This position of the false molar holds in a slight degree in the genus Felis generally, but it is very marked in the fossil.

The obscurity of the sutures and the extent to which the fossil is still enveloped in stone do not admit of our determining precisely the limits of many of the bones of the cranium and face.

The *frontal* is considerably shorter than in the Tiger of the same size, No. 3, and broader; so that it has more squareness of form, at the same time that the ridges stretching from the post-orbital processes, by their prominence and greater convexity inwards, give it an appearance of more sharpness to the rear. These processes are more obtuse and less salient than in the Tiger, and the outline of the frontal

[1] Quoted in Cuvier, Oss. Foss., vol. iv. p. 452.

[2] The presence, or absence, both of the tuberculous and the first false molar appears to be very uncertain in aged *Felinæ*. In a very old Tiger, No. 1 of the measurements, with the canines and all the teeth much worn, both the tuberculous teeth and the small false molar of one side are present. Upon the opposite side all trace of alveolus has disappeared, whereas in younger animals with unworn teeth, we find the tuberculous and first molars less complete.

portion of the orbit is less curved. The separate halves of the bone are convex across, leaving a deep longitudinal hollow between.

The *parietals* are longer than in the Tiger. They are sunk towards their commissure, giving greater appearance of saliency to the sagittal crest. They bulge out at their junction with the *temporals* in conjunction with these bones. The sagittal crest, as noticed above, from its great prominence, is one of the most distinctive characters about the fossil. It is nearly twice as much raised as in the largest-sized Tiger. Its anterior extremity for a short way divides into two, from running in continuity with the post-orbital ridges of *the frontals*.

The *occipital* is large in all its dimensions. It greatly exceeds that of the Tiger of the same size in height, and equals that of the large Tiger, No. 2. Its margins expand greatly laterally, in conjunction with the ridge ascending from the petrous portion of the *temporal* bones.

The *temporal* on the right side is mostly concealed by stony matrix. On the left it is broken at the zygomatic process. The petrous portion is comparatively larger than in the Tiger. The zygomatic arch is elevated and its lower margin is arched more decidedly than in the Tiger. (In this respect it resembles the 'Black Jaguar.'[1]) The posterior angle is more acute.

The corresponding process of the malar differs chiefly from that of the Tiger in the post-orbital apophyses being blunt and very slightly prominent.

The *nasal* bones are considerably shorter than in the Tiger, and they taper less upwards towards their frontal insertion.

The *maxillaries* chiefly differ from those of the Tiger, in their greater prominence along the alveoli of the canines, and the more decided hollow which occupies the infra-orbital region. From the elevated direction of the zygomatic arches, the posterior margin of the maxillaries descending from the malars is higher than in the Tiger. The infra-orbital foramina agree in form and position with those of the Tiger.

The ascending apophysis of the incisive bones runs higher up between the nasals and maxillaries, giving thus a stronger insertion to the bone.

We do not observe any very appreciable difference in the palate, except that the bulge of the canines, and the inward direction of the large false molars, appear to contract it in width between these teeth.

[1] Oss. Foss., vol. iv. Plate xxxiv. fig. 7.

The orbit is smaller than in the Tiger; the post-orbital processes of the malars and frontal are more apart, and the osseous ring consequently less complete.

Regarding the relations of the fossil with respect to other species—

The fossil Lion of Gaylenreath, *F. spelæa*, differs from it in the great size, equalling that of the Lion in the outline of the head, breadth of forehead, depth of zygomatic arches, position of the infra-orbital foramina, and inconsiderable sagittal crest.

The fossil *F. antiqua* differs in being greatly smaller. The existing Lion is much larger, differing also in its rectilinear profile, shortness of head, and want of prominence in the sagittal crest and occipital.

The points of distinction and resemblance with the Tiger have been noticed in detail.

The Panther somewhat resembles the fossil in the moderate convexity of the head, but differs in size and in the little prominence of the sagittal crest. The Jaguar has the same elevated direction of the zygomatic arch as the fossil, but differs greatly in the outline and form of the head.

The Cougouar has one character peculiar to it and the fossil in the genus, in the face being shorter than the cranium; but it differs in size and form.

The other species of the genus differ at once in size.

We have named the fossil the *Felis cristata*, from its most prominent character, the elevation of the sagittal crest.

The position in the genus will probably be after the Tiger. Its size is intermediate between that species and the Jaguar.

We are indebted to Walter Ewer, Esq., of the Civil Service, for an examination of the fossil, which was found by collectors employed by that gentleman, under the direction of Captain Cautley.

Northern Doab: *April* 15, 1836.

XVI. ON URSUS SIVALENSIS, A NEW FOSSIL SPECIES FROM THE SEWALIK HILLS.[1]

BY CAPTAIN P. T. CAUTLEY, AND HUGH FALCONER, M.D.

We are now enabled to record another new form in fossil zoology drawn from the rich deposits of the Sewalik hills. In a preceding article we have noticed a new feline extinct species, of dimensions approaching those of the existing Tiger; in the present one, we shall endeavour to characterize another member of the same family, of the genus *Ursus*, essentially distinct from existing or extinct species in some prominent points of its osteology, and remarkable also for large size, like some other of its associated fossil contemporaries.

Our knowledge of the species is derived from two fossil specimens. The one, consisting of the right half of the lower jaw mutilated at the symphysis and ascending portion of the ramus, exhibited in Pl. XXVI. figs. 3 & 4, gave us the first idea of a new animal. The other, figs. 1 & 2, a subsequent acquisition, is a superb specimen of the head, which, although a good deal fractured, is at the same time so well preserved in its principal features as to cause little difficulty in determining the specific characters. The three rear molars are perfect on one side and but little damaged on the other. Both canines are present, and that of the right side is entire. The alveoli of the false molars and incisors are distinct, although the teeth are wanting. The only considerable deficiencies are in the posterior and lower parts of the occiput, both zygomatic arches, and in the lower end of the nasals, where a fissure extends across the face on both sides towards the orbits.

The chief peculiarities of the fossil are to be found in the teeth, which are constructed *more after the type of the higher Carnivora*[2] than any other described species of the genus.

[1] This paper was published in 1836 in the 'Asiatic Researches,' vol. xix. p. 193, unaccompanied by illustrations. The illustrations in Pl. xxvi. are copied from an unpublished plate (O.) of the 'Fauna Antiqua Sivalensis,' executed about twelve years later, and in which the fossil is designated *Hyænarctos Sivalensis*. In this plate are figured the femur, radius, ulna, and other remains of the fossil in addition to those described in this memoir. In the same plate are figured the portion of an upper jaw with four molars and a tibia of a smaller species of Bear from the Nerbudda, named *Ursus Namadicus* (see Pl. xxvi. fig. 5).—[Ed.]

[2] Underlined in pencil by Dr. F.—[Ed.]

Before entering upon these it will be convenient, for comparison, shortly to refer to the dental system of the Bears generally.

The number of the teeth varies more in the different species of the Bears than in any other genus of the Carnivora. The incisors, canines, and the three posterior molars are constant in both jaws in all the species. The false molars are subject to great variation. They are usually entirely wanting[1] in the upper jaw of the *Ursus spelæus*, or large fossil Bear of Europe, while in other species they amount to three on either side. The same variation holds in the lower jaw. In the *Ursus labiatus*[2] there are four false molars on each side, while in the *Ursus spelæus* there is generally but one present: so that while the number of teeth in the former extends in both jaws to 42, it is commonly reduced in the latter to 30. This irregularity in the number of false molars exists to a certain extent in different individuals of the same species. In one skull of the *Ursus Tibetanus* in our collection, which belonged to an old animal, there are three false molars in the upper jaw on each side; while in the skull of a younger individual with unworn teeth there are but two. In another skull there are no false molars on the left side, while there is one on the right side, there being at the same time three false molars on either side of the lower jaw.

The characters depending on the form of the teeth are very constant in the genus. The carnassier or antepenultimate molar, in the upper jaw, has but two lobes or points along its length; and the tubercle of its inner side is placed opposite the rear lobe. The two rear molars are oblong, and the last one has the additional development of a crenulated spur or heel. The higher Carnivora differ widely in these characters from the Bears; their carnassier teeth being three-lobed, and the tubercle of the inside being placed forwards, as in the Cats and Hyæna, while the rear or tubercular teeth are reduced in number and are rudimentary.

We shall now proceed to the teeth of the fossil, which in many respects deviate from the type of the genus, and approximate that of the more perfect Carnivora. Along with the dimensions we annex those of the *Ursus spelæus* and *Ursus Tibetanus* for comparison.[3]

[1] Cuvier, Ossemens Fossiles, tom. iv. p. 351.

[2] This is constant in several skulls in our collection.

[3] In the 'Ossemens Fossiles,' Cuvier does not give the dimensions in width of the teeth of the *Ursus spelæus*. We have to regret this omission, as one of the most marked characters about our fossil is the great width of the molars; and we have no other source to refer to regarding the *Ursus spelæus* besides the 'Ossemens Fossiles.'

Molars, Upper Jaw	Ursus Sivalensis		Ursus spelæus		Ursus Tibetanus	
	In.	Mèt.	In.	Mèt.	In.	Mèt.
Length of last molar . . .	1·1	·028	1·84	·048	1·1	·028
Width of ditto	1·2	·03	—	—	0·6	·015
Length of penultimate ditto .	1·2	·03	1·23	·031	0·8	·02
Width of ditto	1·2	·03	—	—	0·55	·013
Length of antepenultimate ditto .	1·3	·032	0·83	·021	0·5	·012
Width of ditto	0·85	·022	—	—	0·35	·008
Molars, Lower Jaw						
Length of last molar . . .	—	—	1·03	·026	0·65	·017
Width of ditto	—	—	—	—	0·48	·012
Length of penultimate ditto .	1·15	·029	1·30	·032	0·8	·02
Width of ditto	0·75	·019	—	—	0·45	·011
Length of antepenultimate . .	1·35	·0335	1·32	·033	0·8	·02
Width of ditto	—	—	—	—	0·38	·095
Length of last false molar . .	0·9	·023	—	—	0·4	·01
Width of ditto	0·5	·012	—	—	0·25	·006

The incisors as indicated by the alveoli were six, and the external one of each side larger than the others, as is usual in the family. The canines are of great size. The right one is entire: its point is worn off, indicating the animal to have been more than adult, and there are also stripes of wear both on its posterior and inner sides (fig. 2). It is 1·4 inch in length in antero-posterior diameter at the base, and 1 inch transversely. The socket of the first false molar[1] is close behind the canine, *that of the second is near the anterior one, and the tooth appears to have been two-fanged.*[2] There can have been no other false molars besides these two, the sockets of which are close together, and occupy the interval between the canine and carnassier, which is inconsiderable for the size of head, being but 1·2 inch in length.

The three rear molars present marked peculiarities. The antepenultimate or carnassier is of very large size; it slightly exceeds both of the rear teeth in length, and is about half an inch longer than the corresponding tooth of the *Ursus spelæus*. Instead of having but *two* points like the rest of the Bears, it has *three*,[3] the anterior lobe being well developed as in the higher Carnivora;[4] and the tubercle of the inside, instead of being to the rear as in the other species, is advanced forwards opposite the middle lobe. It has altogether a great analogy

[1] *Note in pencil by Dr. F.*—'This premolar in all the true Bears is described as having but a single fang, and in this view the two alveoli would imply two premolars, here reckoned as one.'—[Ed.]

[2] Underlined in pencil by Dr. F.—[Ed.]

[3] Underlined in pencil by Dr. F.—[Ed.]

[4] *Note in pencil by Dr. F.*—'Such as the Hyæna.'—Ed.]

with the corresponding tooth of the Hyæna. The teeth of the opposite sides are unequally worn.

The two rear or tubercular molars are also marked in their form. Instead of being oblong, as in all the other species, with their length greater by a third than the breadth, they are square in our fossil. The penultimate, if anything, is longer than the rear one, the reverse of which holds in the rest of the genus. It has two tubercles at its outer side, as in other species; at the inside it is somewhat shortened in length, and the cleft between the tubercles is nearly obsolete, so as to give the appearance of one large tubercle. In this respect there is a remote analogy with the corresponding tooth of the Dog, and a deviation from the usual type of the Bears. The last tubercular presents as great a contrast in form with that of the other species as the carnassier tooth does. At its outer side there are two tubercles to the crown smaller than in the penultimate, as is normal in the genus, and at its inner side a ridge indistinctly divided by three slight furrows. There is no heel to the tooth; the crown is square, and the only part which can be considered as representing a heel or spur [1] is a flattish disc at the inside, alternate with the posterior outer tubercle, and partly opposed to the rear portion of it. None of the rest of the Bears have the last tubercular in the upper jaw square, or without a crenulated spur added on to the rear of it.

Our specimen of the lower jaw (figs. 3 & 4) is deficient in the incisors and in the protruded portion of the canine. It is broken off just where the latter emerges from its socket. The section of the embedded portion of the canine gives 1·6 inch of vertical dimension and ·95 transversely. The molars are six in number. The two anterior false molars and the last tubercular have dropped out, but the sockets remain unobliterated. The anterior false molar was close behind the canine, and there is not space for another to have been inserted between. The second was close to the first and almost in contact with the third false molar. This latter, like the carnassier of the upper jaw, is of large size, compared with the same tooth of the other species, and distinctly three-lobed; this is another peculiarity, and further supports the analogy shown by the upper carnassier with the Hyæna, to the second false molar of which it bears a considerable resemblance. The anterior and posterior lobes are small, the middle point being chiefly developed. The antepenultimate or carnassier is so *defined* [2] as to give no indication of form to notice, except its length. The penultimate or first tubercular

[1] *Note by Dr. F.*—'Posterior or talon lobe.'—[Ed.]

[2] Underlined in pencil by Dr. F.—[Ed.]

DESCRIPTION OF PLATE XXVI.

URSUS (HYÆNARCTOS) SIVALENSIS AND URSUS NAMADICUS.

Fig. 1. Profile view of cranium of *Hyœnarctos Sivalensis*, one-fourth of the natural size. The specimen is in the British Museum (No. 39,721), and the figure has been reproduced from an unpublished Plate of the Fauna Antiqua Sivalensis. (See pages 321 & 551.)

Fig. 2. Shows the dental series on the right side of the same specimen as that shown in fig. 1, three-fourths of the natural size. The three rear molars and the canine are perfect, and the alveoli of two false molars are also seen.

Fig. 3. Greater part of the body of the lower jaw of *Hyœnarctos Sivalensis*, one-fourth of the natural size and seen in profile. The specimen is numbered 39,722 in the Brit. Mus. Catalogue, and has been copied from a drawing by Mr. Ford in an unpublished Plate of the F. A. S. (See pages 324 & 551.)

Fig. 4. Alveolar margin with dental series of same fragment of jaw, three-fourths of the natural size.

Fig. 5. Portion of upper jaw, with four molars of a smaller species of Bear from the Nerbudda, *Ursus Namadicus*, one-half of the natural size. The specimen is in the British Museum, No. 39,720, and the drawing has been reproduced from an unpublished Plate of the Fauna Antiqua Sivalensis.

Fig. 1.

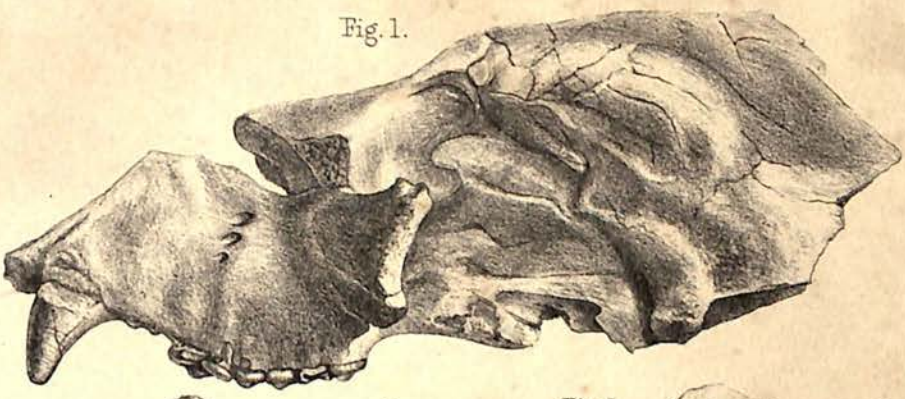


Fig. 3.

Fig. 5.

Fig. 2.

Fig. 4.

G.H. Ford del. J. Dinkel lith.

W. West imp.

1–4. Ursus (Hyænarctos) Sivalensis. 5. Ursus Namadicus.

molar is oblong. It is broader for its length than generally holds in the genus, and the crown is less complicated with tubercles. Of the rear tubercular the socket alone remains, the tooth having fallen out. It is situated with considerable obliquity to the rest of the series in the root of the ascending portion of the ramus. The alveolus is inconsiderable, and the tooth appears to have been comparatively small.

The teeth in the fossil appear to have been thus: incisors, $\frac{3+3}{3+3}$: canines, $\frac{1+1}{1+1}$: false molars, $\frac{2+2}{3+3}$: cheek teeth, $\frac{3+3}{3+3}$: in all, 38.

The size and form of the head bear out the specific distinction established by the teeth. No Bear, fossil or recent, attains the enormous size of our fossil, except the *Ursus spelæus*, and the absence of any bulge in the forehead above the orbits at once distinguishes it from the latter. The mutilation of the cranium at the occiput prevents an exact comparison of the length with that of the *Ursus spelæus*. In the tables of the 'Ossemens Fossiles,'[1] an adult specimen of the latter measures 17·9 inches from the incisors to the occipital crest. The fossil cranium, although mutilated at the occiput, measures 17 inches; with the deficient portion restored, it would probably measure 19 inches. The facial half of the head, from the post-orbital processes to the incisors, measures 9·3 inches; and in almost all the Bears the cranial portion is longer than the facial. Supposing this proportion to hold in our fossil, the head would be more than 19 inches, and would exceed that of the *Ursus spelæus*.

The form of the cranium in profile is shown in fig. 1. The most striking feature is the almost rectilinear outline, and absence of any notable curvature. From along the nasals to between the infra-orbital processes is almost a straight line. There is but a trifling degree of convexity from that backwards; and the sagittal crest rises in a very prominent ridge above the parietals. No species of Bear has so straight a cranium. The *Ursus spelæus* is chiefly characterized by a bulge of the forehead above the root of the nasals. The only species which at all approaches the fossil in profile is the white Polar Bear, *Ursus maritimus*.[2] But besides the great difference of size, the latter has nothing of the salient sagittal crest, which is so prominent in the fossil; all the other Bears have more or less convexity of profile.

Exclusive, therefore, of the teeth, the size and cranial outline would suffice to establish the fossil as a distinct species. The other peculiarities of the head are three. The frontal

[1] Tom. iv. p. 359.

[2] Ossemens Fossiles, tom iv. Pl. xxi. fig. 4.

is very broad, although an accidental indented fracture on the brow takes off from the measurement. The orbits have considerable obliquity, and large size, the depth from the post-orbital process to the malar margin being 3·1 inches. Their anterior margin only advances to above the posterior surface of the rear molar. The temporal ridges are but slightly marked, and meet at an open angle as in the *Ursus spelæus*. From their commissure backwards there is scarcely any sink, the sagittal crest starting with great prominence from the parietals. The crest is not complete in its whole length, being broken off obliquely towards the occipital. The parietals swell out backwards and downwards. The cranial cavity appears to have expanded much laterally towards the occiput, which is broken off. The temporal fossæ are of great depth and extent; the zygomatic arches on both sides are wanting; judging from the depth of the temporal fossæ they must have been of great expanse. The malar apophysis comes off low and is $2\frac{1}{2}$ inches in height. The nasals are partly removed by a fissure in the fossil extending across the face. They appear to have been rather long, and the external opening of the nostrils to have been much shorter and less oblique than in the *Ursus spelæus*. The muzzle is broad and obtuse, being about one-fourth of the length of the head, and a little wider than the inter-orbital portion of the frontal. In this respect it resembles the *Ursus labiatus*. The palate is strongly arched both longitudinally and transversely; the greatest depth from a line across the worn molars to its surface being 2·3 inches. The horizontal plate of the palatines hardly extends an inch beyond the rear molar, whereas in a head of the *Ursus labiatus*, measuring a foot in length, it extends more than two inches. The palatine sinus is also proportionably narrow for the size of head.

In place of a single sub-orbital foramen there are three distinct foramina, nearly of the same size, placed over each other and a few lines apart (Pl. XXVI. fig. 1). They are considerably advanced on the jaw, the uppermost being 1·6 inch from the margin of the orbit and placed over the carnassier. It is difficult to say whether this is common to the species, or merely an individual peculiarity. Nothing of the sort is seen upon the heads figured in the 'Ossemens Fossiles.'

We only know the lower jaw by the fragment represented in fig. 3. It consists of the greater part of the body of the right side, broken off where the canine protrudes. It is also deficient in the articulating and coronoid processes. There is, therefore, little to remark about the form. The lower edge has a good deal of curvature backwards, and the outer

surface is deeply indented by a muscular hollow towards the angle. The dimensions of the fragment are thus:—

Extreme length of the fragment	10·3 inches.
Height of jaw over first false molar	2·5 ,,
Ditto between the two rear molars	3·0 ,,
Greatest thickness at rear molar	0·9 ,,

We have not yet found out or identified any bones of the trunk or extremities. The species does not appear to have been abundant, as no other specimens of the head or teeth have been discovered, so far as we know, among the immense collections of fossil bones got from the Sewalik hills.

The dimensions of the cranium, contrasted with some of the measurements of the *Ursus spelæus* for comparison, are thus:—

Dimensions of Cranium	Ursus Sivalensis		Ursus spelæus	
	In.	Mèt.	In.	Mèt.
From the incisives to the occipital crest[1]	—	—	17·9	·457
Width of cranium between post-orbital processes	5·45	·139	4·7	·121
From the incisives to a line between ditto	9·3	·237	8·6	·245
From occipital crest to the same point[1]	—	—	11·2	·285
Width of brow between the orbits	4·7	·121	—	—
Ditto of muzzle over the canines	4·8	·122	—	—
Length from the alveoli of the incisors to the posterior margin of the palate	7·3	·186	—	—
Width of palate in the interval between the carnassier molars	3·35	·085	—	—
Interval between the canines	2·7	·07	—	—

To conclude. It follows, that there existed along with the Mastodon, Sivatherium, fossil Camel, &c., of the Sewalik deposits, a large distinct species of Bear, equalling if not exceeding the largest known of the genus. Its teeth deviated widely from the type of the genus, approximating it more to the higher Carnivora than to any other species; the carnassier teeth of the upper jaw connecting it with the Hyæna, while the tuberculars have a more remote analogy with those of the Dog. The size and extent of the temporal fossæ, and the prominence of the sagittal crest, taken in conjunction with the teeth, show that it had a more strictly carnivorous than a frugiverous habit.

We have designated it *Ursus Sivalensis*.

[1] These two measurements are incomplete in the fossil, from the mutilation at the occiput. The first or extreme length is 17 inches, or ·434 mètre, the second 7·7 inches or ·197 mètre.

APPENDIX.

I.—Manuscript Memorandum by Dr. Falconer, 1842.

In a communication read before the Academy of Sciences, on the 26th July last (1841), contained in the 'Comptes Rendus' of that date, M. de Blainville has given a revision of the animals allied to the Badger, which have been separated from the genus *Ursus* of Linnæus. He takes up the whole of the species, existing and fossil, comprising them in a group to which he applies the name of *Subursus*, which he ranges in three Sections:—*Meles*, or Badgers; *Procyon*, or Racoons; and *Ratel* and *Caudivolvulus*, including *Arctitis* and *Cercoleptes*, the Binturong and Kinkajou. At the head of this group, preceding the Badger, but excluded from any of the three sections, he places the *Ursus Sivalensis* of Falc. and Caut. described in the 19th vol. of the Asiatic Researches, raising it to the rank of a distinct genus, to which he provisionally assigns the name of *Sivalarctos*. It is strange that M. de Blainville should have adopted this term, while convinced against its being a Bear. If he thought it nearer the Badger, *Sivataxus* or *Sivameles*, should such combinations be admissible, would have been more appropriate. But we cannot assent to his conclusion. The Sewalik species still appears to us to be nearer the true Bear than any other of the Plantigrade Series. M. de Blainville's remarks on the subject are thus: 'Dans ce groupe,' (*Subursus* ou les Petits Ours), 'réduit aujourd'hui en Europe au seul Blaireau, et dont quelques ossements ont été recueillis dans le diluvium des cavernes, j'ai eu l'avantage de trouver à l'état fossil, outre les traces de plusieurs autres espèces, les *indices certains* de cinq formes animales assez différentes pour constituer cinq genres distincts dans la manière admise par les zoologistes modernes, c'est-à-dire, d'après le système dentaire (p. 165).'

'Le premier, que je désigne sous le nom de *Sivalours*, est établi, d'après la description détaillée et comparative, avec mesures linéaires, d'une tête presque entière pourvue de ses dents, publiée par MM. Hugh Falconer et Cautley, sous le nom d'*Ursus Sivalensis*, et qui diffère notablement par la forme, la proportion et le nombre des dents molaires, en général plus carnassières, de toutes les espèces d'Ours aujourd'hui connues. Cette tête provient des terrains tertiaires des monts Sous-Himalayahs dans l'Inde.' . . . . . Nous pouvons encore rapporter probablement à ce groupe le singulier fossile que MM. Cautley et Falconer ont décrit sous le nom d'*Ursus Sivalensis*, qui n'appartient certainement pas à ce genre, que nous avons désigné provisoirement sous le nom de *Sivalarctos*, et dont les ossements ont été trouvés dans cet immense dépôt tertiaire de conglomérat qui remplit toutes les pentes et les excavations des monts Sivaliens ou Sous-Himalayahs (p. 179).' In another place he calls the fossil 'cette tête d'Ours prétendu des monts Sivaliens.'

We have here M. de Blainville's opinion given in two degrees of affirmation: in the first instance that the so-called *Ursus Sivalensis* differs in its teeth from all known Bears, and constitutes a distinct genus of the Subursine group; in the second, that it certainly does not

belong to the genus *Ursus*, but *probably* to the Subursine group. We beg leave to take exception to both inferences.[1]

II.—Extract from Dr. Falconer's Note-book.

(*British Museum, Nov.* 21, 1857.)

Made a rough comparison of a huge ursine head from South America, (Bravard, Buenos Ayres) referred to by Lartet, with the *Hyænarctos* of the Sewalik hills.

Upper Dentition.—All the teeth on their alveoli present on both sides, and the number exactly identical with that of the *Hyænarctos Sivalensis.*

1. A small premolar, touching the canine, is present on the right side.

2. A two-fanged premolar, the alveoli only remaining on both sides.

3. A tooth resembling in general form the third of *Hyænarctos*, but more worn and broader for the length. Instead of presenting three exterior cusps, the flat summit, which is much worn, only shows the discs, which are confluent, of two lobes, the anterior small cusp, which is so well defined in *Hyænarctos*, being wanting; but there is the great agreement of a mesial inner cusp placed opposite the transverse axis, as in *Hyænarctos.* Its worn disc is confluent with that of the outer cusps.

4. A square molar, consisting of two outer and two inner cusps, the outer pair having the discs confluent, and also the inner. It is more moderate in form than the Sewalik tooth. This fourth resembles in form the last of *Hyænarctos.*

5. A last molar, as in *Hyænarctos*, which, instead of being quadrate, has the inner posterior discous surface produced behind, so as to make the tooth oblong instead of square. The outer line, as in the Sewalik fossil, consists of two tubercles.

Lower Dentition.—In number, the lower teeth are also the same.

1. A small one-fanged premolar touching the canine (not seen from fracture in *Hyænarctos*).

2. A two-fanged premolar, shown by the alveoli, which are more approximated than in the Sewalik fossil, and are straight fore and aft (upper being diagonally oblique); doubtful if one or two.

3. A premolar, which is rounder, broader, and thicker, as in the upper jaw, than the corresponding tooth of the lower jaw in *Hyænarctos*; in the latter, it is three-cusped, but in the American fossil, bi-cusped; front cusp wanting, middle cusp very large.

4. A carnassier which, as in the Sewalik form, is the most elongated of all. In the Sewalik specimen the crown is hammered off, so as not to admit of comparison.

5. A tooth homologous in form to the penultimate of *Hyænarctos*, but thicker.

6. A last or tubercular, which is worn down to a roundish disc, as in the Bears, is the smallest of the three, and not much larger than the third premolar.

This tooth in *Hyænarctos* is only shown by its alveolus.

[1] In an unpublished plate, however, of the 'Fauna Antiqua Sivalensis,' executed about 1848, the species is designated *Ursus* (sub-genus *Hyænarctos*) *Sivalensis.*—[Ed.]

Upper canines very large and thick: incisors six; outer with a broad top; middle very much compressed across; they are very much and flatly worn; so also are the canines, but unequally on the opposite sides, the left being ground nearly to the level of the incisors; the converse with like characters in lower jaw, left canine being most worn.

The form of the skull differs much from *Hyænarctos*; it is much broader, deeper, shorter, and thicker. The Sewalik form is more elongated in every direction.

This difference is strongly shown in lower jaw. The Sewalik is thin and high; the American fossil is thick and massive. The American was a larger form, and was probably more heavy and less lithe.

From the very decided flat grinding of the teeth, the American fossil was probably a vegetable feeder; the Indian was evidently an animal feeder.

XVII. ON ENHYDRIODON (AMYXODON), A FOSSIL GENUS ALLIED TO LUTRA, FROM THE TERTIARY STRATA OF THE SEWALIK HILLS.[1]

BY H. FALCONER, M.D.

Till comparatively lately naturalists were only acquainted with the aquatic *Mustelidæ* through the true Otters; and the few species known were so much alike, and so well defined, that Cuvier ranked them merely as a sub-genus of *Mustela*. Subsequent researches brought to light a remarkable deviation from the ordinary type, in the dentition of *Enhydra*. The genus which we are now to describe exhibits a still wider departure from the Otter form in its teeth, the carnassier being so singularly modified that, when detached, it is with difficulty recognized to be that carnivorous tooth. At the same time the other characters of the head are so clear and marked that not a shadow of doubt remains in regard to the animal having been a true lutrine *Mustelida*. The genus is further remarkable in the tribe for the size which it attained, one of the species having been nearly as large as the Indian panther.

The specimens on which the determination rests are three heads (see Pl. XXVII.), which taken together are so complete in regard to the teeth and general form of the cranium, that little remains to be desired respecting the more important characters, except the form of the articular surface for the lower jaw, which is not shown in any of the specimens. There is also a fragment of the lower jaw, containing the two rear molars, but it wants the ascending ramus and condyle.

[1] This paper was written in December 1843, but was never published. The three heads referred to in the memoir are now in the British Museum, and were figured in an unpublished plate of the 'Fauna Antiqua Sivalensis,' (P.) On this plate the species is named *Enhydriodon ferox*. The specimens were afterwards named by Dr. Falconer on labels in the British Museum, *Enhydriodon Sivalensis*. On the same plate of the Fauna a skull and a lower jaw of another new species of Otter are figured, under the designation of *Lutra Palæindica*. These specimens are also in the British Museum, Cat. Nos. 37,157 and 37,152 (see description of Plate P.). The annexed drawings in Pl. xxvii. have been copied from the unpublished plate of the Fauna, above referred to.—[Ed.]

In order to follow the relations of the teeth of *Enhydriodon*[1] it is necessary to review the dental system of *Lutra* and *Enhydra*.

The formula in *Lutra* is: incis. $\frac{3+3}{3+3}$; can. $\frac{1+1}{1+1}$; mol. $\frac{5+5}{5+5}$; $=\frac{18}{18}=36$. In the *Enhydra* (as shown in the solitary skull preserved in the Museum of the Zoological Society): incis. $\frac{3+3}{2+2(!)}$; can. $\frac{1+1}{1+1}$; mol. $\frac{4+4}{5+5}=\frac{16}{16}=32$. The dental system of the Otters is built very much on the plan of the Martins (Fred. Cuvier, in 'Ossemens Fossiles,' art. 'Dentition of the Carnassiers,' vol. iv.) with which it agrees numerically, except in having a false molar less on either side of the lower jaw. But in the signification of the teeth they differ materially in the increased development of the tubercular of the upper jaw, and in the greater degeneration, so to speak, of the carnassier. The typical tubercle on the inside of the latter, instead of being limited to a small knob connected with the body by a narrow base, constitutes nearly half the surface of the coronal, and is expanded into a wide disc, bounded on its inner side by a sharp raised edge, occupying the whole length of the inside of the tooth. The outline of the carnassier is in consequence nearly triangular. The body is still distinctly tricuspid, as in the higher Carnivora, but the anterior cusp is reduced to little more than a well-marked serrature or lobe of the basal ridge. The tubercular has a development proportionate to that of the tubercle of the carnassier. It is somewhat trapezoidal in the outline of its coronal, which is oblong in the transverse direction, that is, considerably broader than long; it is divided lengthwise by a deep hollow into two somewhat unequal halves, the outer and smaller of which is subdivided by a shallow transverse channel into two flattish surfaces bounded by a raised edge; while the inner is expanded into a flat disc, bounded by an edge, as in the tubercle of the carnassier, but it is of greater extent and more complicated in form. This arises from the anterior border of the coronal being raised up into a prominent trenchant ridge divided into two denticles, and distinct from the bounding basal ridge which sweeps round it.

In the lower jaw the tubercular is of comparatively small size, nearly square, and its coronal is divided by a transverse low ridge into two flattened nearly equal surfaces. The carnassier may be considered as made up of two parts, separated

[1] So named from ἔννυδρις the Greek word for Otter, and ὀδούς. The name has no special reference to the modern *Enhydra*, which has a similar derivation.

by a deep transverse hollow, the anterior of which is formed of three sub-equal pointed cusps disposed in a triangle, the inner one representing the tubercle of the corresponding upper tooth; the posterior portion consists of a dilated flattened tubercle, sloping inwards, and bounded by a sharp edge, which is raised at the outer side into an obsolete posterior cusp, less distinctly marked at the inner side.

The false molars, canines, and incisors of the Otter agree so closely with those of other *Mustelidæ* as not to require special notice. In regard to the 'wear' of the molars generally, we may remark that from age and use they get blunted and irregularly ground down; but the cusps never wear off into the truncated depressed transverse discs exhibited in the teeth of Hyænas, a remarkable approach to which takes place in those of *Enhydriodon*, to be noticed more particularly in the sequel.

In the *Enhydra* the teeth undergo a singular modification, both in number and configuration. It has normally the same amount of molars in the lower jaw as the true Otters, and one false molar less in the upper jaw, so that the dental formula, if regularly followed out in the canines and incisors would be $\frac{16}{18}=34$; but from a peculiar suppression there are only four incisors in the lower jaw, the outer and largest one on each side being wanting. The canines are only remarkable for their small size in relation to the other teeth and the bulk of the head.

But it is in the form of the molars of *Enhydra* that the great deviation from the type of the Otters is observed. They are large, robust, and amorphous: the coronal being composed of a very thick layer of enamel. Everything like the pointed cusps and trenchant edges of the Otters' teeth has disappeared, and given place to a flattened, sinuous, and obtusely tuberculated surface; like the worn tubercular teeth of the Bears. This is not a result of age, but is shown in the young animal when the sutures of the head are still open. Notwithstanding this disguise, the amorphous-like inequalities can be traced to a modified representation of the cusps and lobes of the teeth in the Otter. The upper carnassier is of a triangular form, divided by a longitudinal furrow, the outer portion being formed of two very obtuse rounded tubercles, the anterior of which is the largest, representing the central cusp of the carnassier of the Otter; but there is no trace of the anterior lobe of the latter. The internal portion is still larger than in the Otter, and consists of an expanded disc raised into a third obtuse tubercle, and bounded by a blunt basal ridge. The upper tubercular is of

an irregular ovate form, and has the same obliquely transverse direction as in the Otter. The surface is so flat and sinuous that it is difficult to recognize its constituent elements; but it is divided, as in *Lutra*, by a shallow furrow; the outer portion consisting, as in the latter, of two unequal tubercles; the inner, which is much larger, is elevated into three obtuse tubercles, arranged in a triangle, and surrounded by a blunt ridge.

In the lower jaw the tubercular is comparatively small, as in the Otter. It is oblong across, and umbilicated, with four indistinct surfaces surrounding the depression. The carnassier is of a broad ovate form; the flattened surface of the crown being raised into four inequalities, representing the three cusps and heel of the corresponding tooth in the Otter. The false molars in both jaws are only remarkable for their robust and obtuse form.

These minutiæ may appear tedious, but we have found it necessary to enter into them so much at large, as the dentition of the fossil genus occupies in certain respects a mean position between that of *Lutra* and *Enhydra*. In determining fossil animals no assistance is derived from the soft parts, or external characters; the means for their identification are often limited, as in the present instance, to an isolated part of the skeleton; and the anatomist has it forced upon him to go rigidly into the comparison of every character, in order to be able to apply with any certainty the laws which regulate correlative organization to the reconstruction of the form, and the determination of its affinities.

Now, in regard to the teeth of *Enhydriodon*. The specimens, fortunately, supply information regarding all those of the upper jaw, even to the deciduous precanine false molar. The incisors (Pl. XXVII. fig. 2) are of the normal number, three on each side, the two interior of which are shown by their transverse section to have been very compressed, their length being three times their width. This compression, so much greater than what is seen in either *Lutra* or *Enhydra*, or in any other described *Mustelida*, is palpably connected with the enormous development of the outer incisor on either side, which relatively exceeds that of any known Carnivora. This lateral incisor evidently served as a subsidiary canine,[1] and the only analogous case which occurs to us is found in a

[1] From this canine character of the outer incisor, we were induced, in the first instance, to name the genus *Amyxodon*, or, par excellence, Lamarian, but subsequently adopted that of *Enhydriodon* as significant of its affinities, a useful consideration in naming fossil mammiferous genera. It is mentioned under the name *Amyxodon* in a catalogue of Sewalik fossils in the Journal of the Asiatic Society of Bengal, vol. iv, 1836, p. 707, and in Dr. Royle's 'Illustrations of the Botany of the Himalayahs,' vol. i. p. 31.

DESCRIPTION OF PLATE XXVII.

ENHYDRIODON SIVALENSIS AND LUTRA PALÆINDICA.

All of the figures in this Plate have been reproduced from drawings by Mr. Ford in an unpublished Plate of the Fauna Antiqua Sivalensis. Figs. 1 to 5 are rather less than one-half (about $\frac{4}{9}$) of the natural size; figs. 6–8 are two-thirds of the natural size. All of the specimens are in the British Museum.

Figs. 1 and 2. *Enhydriodon Sivalensis.* Anterior portion of cranium of a young and probably female individual. B. M. Cat. No. 37,154. (See pages 334 & 553.)

Figs. 3 and 4. *Enhydriodon Sivalensis.* Two views of cranium, probably of a female. B. M. Cat. No. 37,153. (See pages 331 & 552.)

Fig. 5. *Enhydriodon Sivalensis.* Anterior portion of cranium of an old individual, with very perfect alveolar ridges. B. M. Cat. No. 37,155. (See pages 331 & 553.)

Figs. 6 and 7. *Lutra Palæindica.* Two views of cranium with very perfect alveolar ridges. B. M. Cat. No. 37,151. (See page 552.)

Fig. 8. *Lutra Palæindica.* Lower jaw with a large and very perfect carnassier. B. M. Cat. No. 37,152. (See page 552.)

Fig. 6.

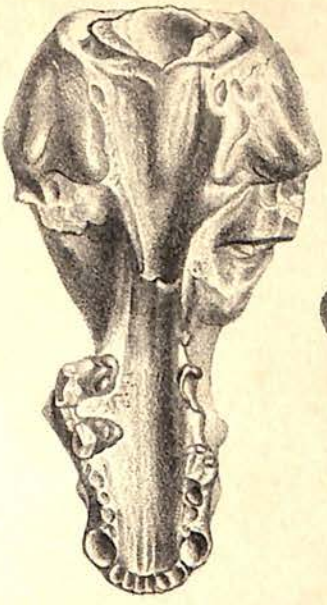


Fig. 1.

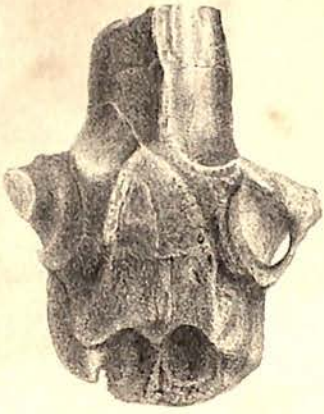


Fig. 2.

Fig. 7.

Fig. 8.

Fig. 3.

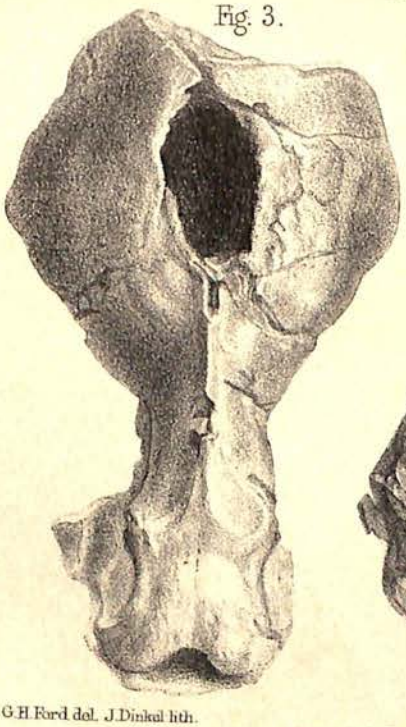


Fig. 5.

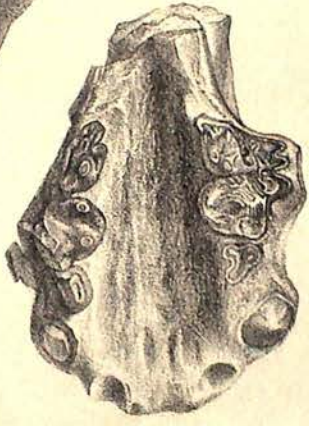


Fig.

G.H.Ford del. J.Dinkel lith.

W.W

1–5. Enhydriodon Sivalensis. 6. 8. Lutra Palæindica.

very different family, the Ruminantia, where the upper lateral incisor puts on the form and development of a canine, in the Camel. In one of the specimens (fig. 2), the base of this tooth, with the other incisors, remains in the jaw, broken off on a level with the alveolus, and enables us to determine its relative size with precision. The section of the fang shows a very broad oval; the dimensions, as contrasted with those of a large Indian Otter, are [1]:—

	Enhydriodon	Indian Otter
	Inch	Inch
Antero-posterior diameter outer incisor	·45	·17
Transverse ditto ditto	·37	·12
Antero-posterior diam. middle incisor	·33	·14
Transverse ditto	·14	·1
Antero-posterior diam. of inner incisor	·25	·09
Transverse of ditto	·09	·08

In the younger animal, to which the head (fig. 2) belonged, the incisors are all present; but in the older head (fig. 5), the middle incisors are not only wanting, but the alveoli are completely filled up and obliterated, there being nothing but a blank space between the outer incisors. In this deciduous character of the middle incisors *Enhydriodon* agrees with the modern *Ursus* (*Prochilus*) *labiatus*, or so called Sloth Bear of India, in which the incisors drop out as the animal increases in age. None of our specimens show what the number and character of the incisors were in the lower jaw; but such a strongly-developed lamarian tooth in the upper must in all probability have had something corresponding to oppose it in the lower jaw; we therefore infer that there were two large outer incisors, one on each side, below, and that the four middle incisors were also present, for in *Enhydra*, where there is a suppression of two incisors, it is the outer one on each side that disappears, the central ones remaining. This is proved by the form of the exhibited incisors.[2]

The canines of the upper jaw, like the lateral incisors, were proportionately large, and of great strength and massiveness. A section of the right one is got in the head fig. 5, of a circular form. The dimensions are, antero-posterior diam. 5½ lines, transverse do. 4¾. In the head, fig. 2, both

[1] The measurements, which were omitted from the original MSS. have been filled in by me from specimens in the British Museum.—[Ed.]

[2] Mr. Martin, in the abstract of his paper on *Enhydra*, contained in the Proceedings of the Zoologl. Society for June 14, 1836, appears to consider that the suppressed incisors in the lower jaw of *Enhydra* belong to the middle ones. But a close examination of the form of the teeth leads to the conclusion stated above.

the canines had dropped out, and the two alveolar cavities are exposed, showing that the fang was comparatively short, and much dilated, evincing a resemblance in this respect to the canines of the *Seals*.

We have nothing to indicate what the lower canines were, but it is legitimate to infer their existence and correspondence with the upper teeth.

The molars in the upper jaw of *Enhydriodon* were, as in *Enhydra*, four—two false molars, a carnassier, and a tubercular. This is seen to have been the number in both the fossil species with which we are acquainted. The first, or precanine, was a very small and rudimentary tooth, deciduous in the adult animal. The alveolus for it is distinctly shown on both sides of the head, fig. 2, which belonged to rather a young animal, and probably a female,[1] as the tooth is retained longer by this sex than by the other. The second had two fangs, and instead of having the flattened form which it has in the Otter, terminating in a pointed cusp, it appears to have been short, thick, and blunt, as in *Enhydra*. It was encircled by a rugged basal ridge, or burr. None of the specimens show more than a section of it, the crown being broken off in all of them; but the form and burr are best seen in the left side of the old head, fig. 5.

The upper carnassier is singularly remarkable in the form of its coronal lobes generally, and in the extent and complicated development of its interior portion. It constitutes the most typical feature of the genus, and has nothing that we know of analogous to it in the family of Carnivora, fossil or recent. It was remarked both of *Lutra* and *Enhydra*, that their carnassier was more or less triangular in its outline. In *Enhydriodon* it is nearly square; and instead of the cusps and trenchant ridges of *Lutra*, or the flattened inequalities of *Enhydra*, the coronal lobes are developed in conical mammillæ, somewhat like those of the mastoid-toothed Pachydermata. Fig.[2] represents a perfect carnassier detached, of the left side of the smaller species. It is divided by a deep longitudinal flexuous hollow into two portions; the outer or typical body of the carnassier is distinctly three-lobed, the middle lobe being the largest and elevated into a conical mammilla, the other two being blunt tubercles. The inner portion, equalling the size of the outer, is composed of two thick conical mammillæ, separated by a deep hollow; the anterior mammilla has its posterior margin notched near the base into two additional denticular lobules. The posterior

[1] This conjecture and the grounds upon which it is founded were suggested by Prof. Owen.

[2] This specimen has been unfortunately mislaid, and was never figured. It is not in the British Museum.—[Ed.]

mammilla is nearly of the same size, but simple. It is this posterior lobe, of which there is no trace in the Otter or *Enhydra*, that, so far as regards the composition of the coronal, distinguishes the carnassier of *Enhydriodon* so strongly from that of other Carnivora. In its great features this tooth looks as if made up of three nearly equal conical mammillæ disposed in triangle, two occupying the inner side, and one at the outer bearing a lobe at each end. In the larger species[1] it has precisely the same form as in the small one, showing it intact from wear, the only difference being that the inner portion is, if anything, larger. The manner in which the 'wear' of the tooth goes on is seen in all the specimens, the apices of the mammillæ being truncated off horizontally, so as to form depressed discs, surrounded by a thick ring of enamel resembling what is shown upon the teeth of old Hyænas, and on the molars of the Phacochœrine Hogs. We have noticed that the teeth of *Enhydra* and *Lutra* do not show a 'wear' of this sort.

APPENDIX TO MEMOIR ON ENHYDRIODON.

I.—MS. Memorandum by Dr. Falconer, 1845.

Compared the head of Indian Otter (recent) with four heads in College of Surgeons. It is about half inch longer than any of them; the naso-frontal oblong in Indian; nearly square in European, or approaching square. In one head, No. 295, of an old animal, it is very square. Post-orbital part of frontals is more elongated and more contracted in Indian, but great difference in this respect in the European. In No. 295 it is very broad and short, wider than long; while in another, No. 55, from the side cases, the sides converge backwards into a very narrow contraction, half the width of No. 295; this is also an old head.

II.—Memorandum in MS. made at Dr. Jameson's, Suharunpoor, Jan. 21, 1841.

Dimensions of a Lower Jaw fragment. Enhydriodon.

Fragment consists of the posterior part of the lower jaw, left side, with the ramus broken off above the base of temporal fossa; condyles, &c., removed. The carnassier tooth and a solitary tubercular are *in situ*.

Dimensions.

	Inches
From the anterior margin of carnassier to the rear of the tubercular	1·4
Length of the carnassier	1·
Width of ditto	·4
Length of tubercular	·45
Width of ditto	·3
Height of jaw to base of carnassier	1·1
Greatest thickness of ditto	·5

[1] Here and at page 331 allusion is made to more than one species of *Enhydriodon*.—[Ed.]

The carnassier consists of three lobes: the anterior one is a low three-sided pyramid; the middle one is an elevated acute lobe, as in the Otter (it is partly broken off in the specimen), with a small tubercle at the rear of the inner side, which is smaller than in the Otter; the rear lobe consisting of a flattened, nearly horizontal tubercle, nearly plain, as in the Bear, but with a worn low maxillary process or facet at the outside and inside. The tubercular or rear molar is an oblong tooth with an oblique facet directed forwards; then comes an anterior lobe, and then a posterior lobe with a re-entering angle between; the posterior lobe consists of a single flattened point. The corresponding tooth in the Otter is nearly circular in either central point, from which four small facets are given off.

XVIII. ON THE FOSSIL CARNIVORA OF THE SEWALIK HILLS.

[ALTHOUGH the *Felis cristata*, *Ursus* (*Hyænarctos*) *Sivalensis*, and *Enhydriodon Sivalensis* are the only Sewalik Carnivora which have been carefully described, the Sewalik Fauna included representatives of many other genera belonging to this class. Two unpublished plates of the 'Fauna Antiqua Sivalensis' (L. and M.) are devoted to the illustration of the *Hyæna Sivalensis* (Falc. and Caut.), the specimens of which are in the British Museum, while a third unpublished plate (N.) illustrates the remains of the *Machairodus Sivalensis* (Falc. and Caut.), also in the British Museum; and a fourth (Q.) those of *Ursitaxus*, or a species of Ratel. (See descriptions of these plates.) The British Museum collection also contains specimens of fossil *Canis* from the Sewalik hills, which, as well as *Gulo*, was briefly described by Messrs. Baker and Durand in the Journal of the Asiatic Society for Sept. 1836, vol. v. p. 581. These descriptions are annexed, as well as an account by Dr. Falconer of the Sewalik Carnivora in the Museum of the Asiatic Society in Calcutta. A reference to *Machairodus Sivalensis*, from one of Dr. Falconer's note-books, will also be found in vol. ii., under the head of '*Felis spelæa*.'—ED.]

I.—DESCRIPTION BY MESSRS. BAKER AND DURAND OF FOSSIL CARNIVORA FROM THE SUB-HIMALAYAHS.[1]

GULO.

Of this genus we possess the fossil skulls of two individuals, one of which, represented in fig. 4, is nearly perfect: the lower jaws have been separated at their symphysis and otherwise somewhat mutilated, but as they were not found attached to the cranium, we may consider ourselves fortunate in having obtained them at all. The second cranium, fig. 7, has suffered considerable mutilation, and is without the lower jaws; we have, however, inserted it in the plate, because though otherwise less perfect, it has escaped a crush, which appears to have flattened fig. 4. Some differences of proportion between the two fossils would be accounted for under this supposition.

The recent skulls with which we have compared the above-mentioned fossils belong to an animal known by the Hindustani name *Biju* بجو identical, or nearly so, with the Cape *Ratel* (*Gulo Capensis*, Desm.)

[1] The illustrations referred to are those in the 'Journ. As. Soc.'—[ED.]

In classing the *Biju* and *Ratel* under the genus *Gulo*, we follow the common system of arrangement; though, as remarked by Cuvier,[1] both the number and character of their teeth would rather place them with the *Mustela Putorius*. They appear, in fact, to be indebted to their plantigrade motion alone for a place among the *Gluttons*. The fossils now under consideration correspond in dentition with the *Ratel* and *Biju*, and the following table will show that their resemblance to the latter in most other respects is very strong.

	Recent Biju	Fossil	
		Fig. 4	Fig. 7
Extreme length from posterior of occipital condyles to anterior of incisors, taken as the modulus and assumed at	1·000	1·000	1·000
Breadth measured across mastoid processes . . .	0·581	0·592	0·610
Greatest breadth of cranium opposite mastoid processes	0·467	0.443	0·474
Least ditto ditto at temporal fossæ	0·226	0·258	0·262
Height of occiput from inf. margin of foramen magnum to sup. of occipital ridge	0·318	0·307	0·343
Breadth of ditto from point to point of styloid processes	0·335	0·361	0·394
Ditto across the occipital condyles	0·243	0·241	0·248
Ditto of frontal from point to point of post. orbital apophyses	0·286	0·327	0.313
Ditto greatest across zygomatic arches	0·546	0·543	0·561
Ditto exteriorly across the superior canine teeth . .	0·220	0·238	0·236
Perpendicular diameter of occipital foramen . . .	0·088	0·091	0·108
Length from anterior of canine teeth to post. of tubercular teeth, measured externally	0·282	0·287	0·287
Breadth of upper jaw measured across carnivorous molars	0·347	0·339	0·325
Greatest antero-posterior diameter of canine teeth . .	0·058	0·071	0·057
Width of tuberculous molars	0·081	0·073	0·069

The two fossils, though differing considerably from each other, agree in the following points of dissimilarity from the recent skull. Their canine teeth are larger and stronger, and their tubercular molars smaller; the two lines of molars converge towards the muzzle considerably less in the fossil than in the recent animal, and the individual false molars are set less obliquely to the line of maxillary. The frontal is wider between the orbits; the post-orbital apophyses more prominent, and the depression of the cranium in rear of them less deep; the exterior portion of the mastoid processes has a far greater development (fig. 8); the transverse occipital ridge is thicker, more rugged and more prominent, and projects considerably beyond the plane of the occiput in the prolongation of that of the parietal bones (fig. 5). Measurements of the recent and fossil lower jaws exhibit no differences save in the canine teeth, which severally correspond with the same teeth in the upper jaw. There is, however, in the fossil (fig. 6) a deep

[1] Il convient d'autant mieux de comparer le Ratel au Glouton, que ces deux quadrupèdes sont à peu près de même taille; mais outre que le Glouton a six molaires de plus que le Ratel, le crâné de celui-ci est plus large en arrière, son front moins élevé, son orbite moins cerné, ses arcades zygomatiques moins hautes, et l'apophyse coronoïde de sa mâchoire inférieure beaucoup moins haute, plus large, et plus obtuse. Les rapports du ratel avec le putois, d'après ses dents et sa tête, sont certainement plus importans que les différences de marche.—*Ossemens Fossiles*, tom. iv. p. 90.

depression in the ramus, which in the recent species is nearly flat. In our specimen this depression is as marked as in the tiger and other feline animals. The differences above noted tend to prove that the ancient species was even more powerful and savage than its present representative, the Biju itself, which is by no means deficient in these qualities. The three recent skulls examined on this occasion had all suffered more or less from the violence to which the vigorous self-defence of the animals had obliged their captors to resort.

Canis Vulpes ?

The specimen represented in figs. 9 and 10, though fortunate in possessing both lines of molars complete, has suffered much from a crush by which the whole posterior portion of the head has been flattened and disfigured. The dimensions selected for comparison in the following table are those least likely to be affected by the accident. Our recent specimen belongs to an adult male fox, of a species common in the NW. provinces of India. Its size, the colour of its fur, and other external characters, appear to correspond with the description of *C. Corsac* (Pallas), which Cuvier is inclined to identify with *C. Bengalensis* of Pennant—figured also in 'Hardwicke's Illustrations,' Pl. II., Parts XV. and XVI.

	Recent	Fossil
Length from occipital condyle to anterior of canine, taken as modulus, and assumed at	1·000	1·000
Breadth measured across mastoid processes	·390	·433
Least breadth of cranium at the temporal fossæ	·205	·206
Breadth from point to point of styloid processes	·253	·298
Ditto across occipital condyles	·202	·251
Ditto of frontal from point to point of post-orbital apophyses	·287	·295
Greatest breadth measured externally across both lines of molars	·338	·319
Horizontal diameter of occipital foramen	·130	·133
Length occupied by line of molars and canine taken together	·500	·470
Ditto ditto molars alone	·410	·415

The chief differences here exhibited are those of greater breadth in the posterior portion of the fossil's head, and must, though they appear natural, be liable to the suspicion of having been caused more or less by the crush before alluded to; but there are some points of dissimilarity which must be considered free from this objection. The transverse occipital ridge is thicker and higher in the fossil; the post-orbital apophyses are altogether broader and more prominent; the hollow or depression in their upper surface, forming a valley between the outer edge of the apophysis and the swell of the frontal (constituting one of the distinctions between the fox and the other varieties of canis) is in the fossil more marked. From the rear of these apophyses start two ridges, which at first converge towards the occiput in a curvilinear direction, until the distance between them is reduced to about half an inch, after which they run nearly parallel for some distance, and then converge again, till they unite near the occiput and become blended with the parietal crest. We have been particular in describing this formation, as a very similar one was observed by Cuvier in the skull

of the 'Rénard tricolor,' *C. cinereo-argenteus*, Linn. It will be observed from the table of measurements that the length occupied by the molars and canine teeth together is less in the fossil, while that occupied by the molars alone is proportionally greater. This difference is only apparent, and is caused by the advanced position of the first false molar close to the root of the canine; the tooth is probably a deciduous one, not yet replaced by the permanent molar; the unworn state of the other teeth also attesting the youth of the fossil, at the period of its demise. The lower jaws, figs. 11 and 12, are not sufficiently perfect to afford any satisfactory measurements.

To the foregoing observations we have nothing further to add than that, in our opinion, they point out sufficient proof of specific differences between the several objects compared; but, for the reasons before adduced, we must limit our conclusions to this, and cannot therefore venture upon giving new names to our fossil species.

Measurements of Fossil Skulls.

Details of Measurements	Gulo, figs. 4, 5 & 8	Gulo, fig. 7	C. Vulpes, 9 & 10
	In.	In.	In.
Extreme length from post. of occipital condyles to anterior of incisor teeth	5·51	5·08	4·09
Ditto ditto ditto canine ditto	5·13	4·86	3·83
Breadth measured across mastoid processes	3·26	3·10	1·66
Greatest breadth of cranium opposite mastoid processes	2·44	2·41	1·71
Least ditto ditto at temporal fossæ	1·42	1·33	0·79
Height of occiput from lower margin of occipital foramen to top of transverse ridge	1·69	1·74	0·90
Breadth from point to point of styloid processes	1·99	2·00	1·14
Ditto across the occipital condyles	1·33	1·26	0·96
Ditto of frontal from point of post-orbital apophyses	1·80	1·59	1·13
Greatest breadth across zygomatic arches	2·99	2·85	—
Breadth measured externally across superior canine teeth	1·31	1·20	—
Ditto ditto most prominent points of line of molars	1·87	1·65	1·22
Perpendicular diameter of occipital foramen	0·50	0·55	—
Horizontal ditto ditto	0·62	0·60	0·51
Length from exterior of incisors to anterior of palatal sinus	2·40	2·00	—
Ditto from anterior of palatal sinus to lower margin of occipital foramen	2·56	2·70	2·05
Ditto occupied by molars and canine teeth, taken together	1·58	1·46	1·80
Ditto ditto molars alone	1·25	1·17	1·59
Diameter of orbit perpendicular, but measured in plane of orbit's margin	0·62	—	0·58
Ditto ditto from point of post-orbital apophysis to anterior margin of orbit	0·79	—	0·74
Greatest antero-posterior diameter of canine tooth	0·39	0·34	0·18
Width of tuberculous tooth (in *Felis* and *Gulo*)	0·40	0·35	—
Lower Jaw			
Length from posterior of condyle to anterior of canine	3·20	—	—
Ditto from ditto ditto to posterior of molars	1·48	—	—
Ditto occupied by molars and canine teeth, taken together	1·74	—	—
Ditto ditto molars alone	1·37	—	—
Depth of lower jaw taken in front of carnivorous tooth	0·67	—	0·45
Greatest antero-posterior diameter of canine tooth	0·38	—	0·13

II.—Description by Dr. Falconer of Fossil Remains of Carnivora, from the Sewalik Hills, in the Museum of the Asiatic Society of Bengal.

No. 847. *Hyæna.*—Cranium nearly entire, deficient only in the right zygomatic arch, and in the basal part of occiput, but covered with matrix, and the teeth so mutilated that only the second premolar is distinctly seen; the incisors and canines *in situ*, but broken off.

No. 848. *Hyæna.*—Fragment of cranium a good deal crushed, and mutilated behind the orbits, showing all the teeth on the right side except the small premolar; the teeth are considerably larger than those of the existing Indian Hyæna. On the left side canine seen in section.

No. 849. *Hyæna.*—Fragment of lower jaw, right side, containing the four molars *in situ*; teeth larger than in the existing Hyæna, but a good deal concealed by matrix.

No. 851. *Feline*—Fragment of horizontal ramus, lower jaw, right side, containing the two last molars *in situ*; would be about the size of *Felis cristata* (F. and C.).

No. 852. *Canis.*—Upper maxilla, left side, comprising a part of palate and zygomatic portion of orbit.

No. 859. *Hyæna.*—Fragment of hard matrix containing part of the cranium of a carnivorous animal, and showing canine? and portion of premolar, but much concealed by matrix. An Hyæna?

III.—Description by Dr. Falconer of Fossil Hyæna. From Notebook, Jan. 21, 1841.

Dimensions of a large Hyæna, Dr. Jameson's, Suharunpoor.

	Inches
Interval between the outer edges of the third or last false molar of the lower jaw	4·1
Length of the three anterior false molars	1·9
Ditto from anterior side large incisor to the posterior ditto third false molar	3·4
Width of the line of incisors	1·7
Length of posterior tubercular	·9
Thickness of ditto about	0·6
Height of ditto	6·5
Length of second ditto	0·7
Thickness of ditto	·45
Height of ditto about	·4
Interval between the bases of canines	1·9

This specimen consists of the anterior half of the lower jaw both sides, as far back as the rear of the third false molar. The incisors, canines, &c., *in situ*. The teeth considerably worn. The incisors and canines show nothing peculiar. The first false molar is very small, and the second much smaller than the third. They are placed obliquely in the jaw. Section of the canines oval. A very large species.

XIX. ON THE FOSSIL CROCODILES OF THE SEWALIK HILLS.[1]

BY CAPTAIN P. T. CAUTLEY.

Of the skulls of the existing Crocodile, from which the measurements accompanying this note have been taken, one belongs to an animal 7 feet long, of which we have the perfect skeleton; and the other was stated by the person from whom it was procured to have belonged to an animal of 12 feet. We have a correction, however, in the smaller specimen, which was carefully measured; and taking this as a type, the animals being of the same species (*C. biporcatus*, Cuvier), a mean of four measurements gives us a length of 132·09 inches, or 11 feet ·09 inches, for the latter. In fixing this specimen as belonging to an animal of 11 feet, we shall not therefore be far from the truth.

There is so much difference in the few comparative measurements that we have been able to obtain of the fossil, with these two skulls, that it is hardly possible to take any proportion of the existing animal as a guide to that of the fossil; the measurements taken separately would in some cases reduce our fossil to that of an animal of 11 feet, with distinct ocular proof to the contrary; in others the fossil animal would be 17 feet long, which may probably be somewhere near the actual size; while an assumption of 20 feet would be extending the dimensions to their utmost limit, our estimate being guided by the proportions of the species now existing in our rivers.

The fossils from which the measurements were taken consist of two very perfect fragments; First, the anterior portion of the skull of a large and adult animal, the posterior

[1] Reprinted from the Asiatic Researches, vol. xix. p. 25, 1836. The original memoir was illustrated by rough, though characteristic, drawings. The drawings illustrating this reprint (Plates xxviii. and xxix.) have been made by Mr. Dinkel from more perfect specimens in the British Museum. Most of the specimens, however, drawn in the 'Asiatic Researches' are also in the British Museum. Thus, Plate ii. figs. 2 and 4, As. Res., is No. 39,801 in Brit. Mus. *C. biporcatus* (*sic*); and Plate iii. figs. 3 and 5, As. Res., is No. 40,206 Brit. Mus. *Lep. Gangeticus*. By referring to appendix it will be seen that the identification of *C. biporcatus* in memoir ought to have been *C. bombifrons*.—[Ed.]

DESCRIPTION OF PLATE XXVIII.

CROCODILUS BOMBIFRONS AND LEPTORHYNCHUS GANGETICUS.

The figures in this Plate have been drawn by Mr. Dinkel from the original specimens in the British Museum, which have been identified with outline tracings named by Dr. Falconer.

Fig. 1. Lateral view of fossil skull and lower jaw of *Crocodilus bombifrons*, a species still existing in India. The drawing is one-fifth of the natural size. The number of the specimen in the British Museum Catalogue is 39,798. (See page 355, and vol. ii. page 485.)

Figs. 2 and 3. Another skull of *Crocodilus bombifrons*, showing upper and palatal surfaces, and drawn one-fifth of the natural size. The number of this specimen in the British Museum Catalogue is 39,795.

These two specimens of *C. bombifrons* belong to the same species as that identified in Capt. Cautley's memoir as *C. biporcatus*, but are more perfect than the specimens which he described, but which are also in the British Museum. (See page 344, *note*.)

Figs. 4 and 5. *Leptorhynchus Gangeticus*. Upper and under surfaces of cranium, drawn one-sixth of the natural size. The number of the specimen in the British Museum Catalogue is 39,809. The species is the same as that described in Capt. Cautley's paper as *Croc. longirostris*, and is the existing Gavial of the Ganges; and the specimen closely resembles, but is more perfect than, that figured by Capt. Cautley in the 'Asiatic Researches,' vol. xix., Plate III., figs. 3 and 5, the Catalogue number of which in the British Museum is 40,206.

Fig. 1.

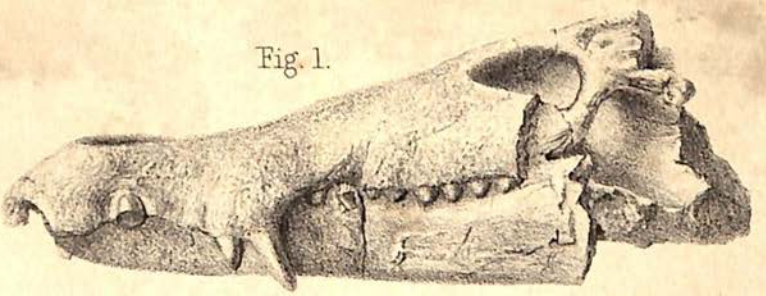


Fig. 2.

Fig. 3.

Fig. 4.

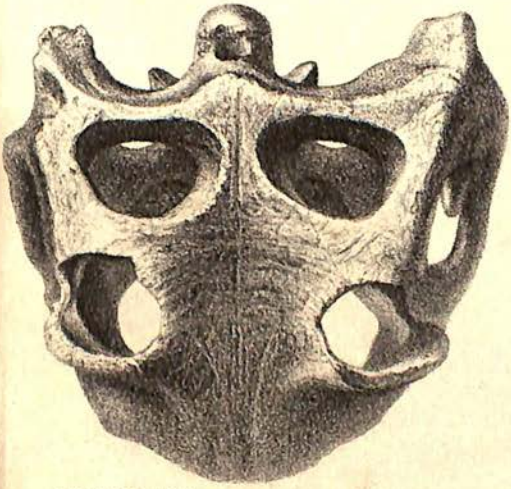
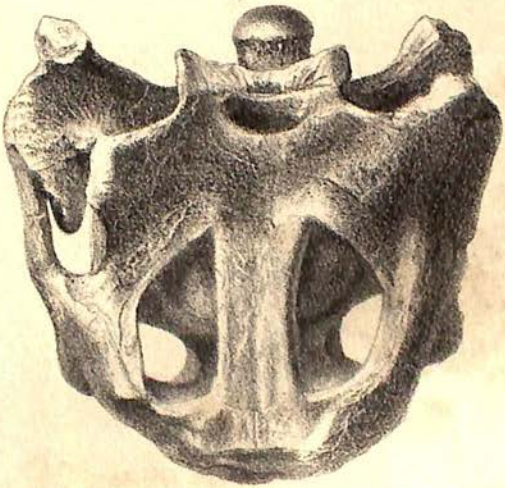


Fig. 5.



J. Dinkel del. et lith. W. West imp

1, 2, 3. Crocodilus bombifrons. 4, 5. Leptorhynchus Gangeticus.

part from the palatal sinus being wanting;[1] in this the front of the lower jaw consisting of the left dental from the 1st to the 8th tooth, and of the right from the 1st to the 4th, is fixed—the fragments of the upper and lower jaw being united: a point proving that some at least of these remains were inhumed before the disintegration of the muscles and integument connecting them; and, secondly, the posterior part of the skull, from the occipital to the front of the orbits, of an adult, but of a smaller animal than the preceding.

The 4th tooth in each side of the lower jaw being received into a groove into the upper, the form and size of the cranial foramina, together with those of the protuberances and indentations of the muzzle, place our fossil amongst the true Crocodiles, the species being *allied* to Cuvier's *Biporcatus*, or the Crocodile, '*à deux arrêtes*' now existing in these rivers.

The following measurements will facilitate the reference to Cuvier's 'Ossemens Fossiles,' and be perhaps of still further use in providing the means for general reference on points relating to the existing Crocodile (See p. 346).

From the sutures being obliterated on the upper rugged surface of the fossil, the junction of the lachrymal and anterior frontal on the maxillary bone is not observable, and as this is one of the points upon which the Cayman and Crocodile differ, it is perhaps to be regretted that this must remain at present doubtful; for although the characters above given distinguish the fossil from the Cayman, the bluntness of the muzzle and the proportions of the bones of the head do, in some respects, assimilate it with the latter sub-genus.

On the lower smooth surface the sutures are well defined, and it is on this measurement that we observe the remarkable distinction between the existing and the fossil animal; the shortness of the maxillary bones and the length of the intermaxillaries, including the nasal aperture, are peculiarities that will be observed in the table of measurements, the former (maxillary) in the existing animal being to the latter (intermaxillary) as 3·9 is to 3·2; in the fossil as 3·8 is to 4·3. The length of the maxillary bones on the lower suture, or the space separating the palatine from the intermaxillaries, is rather greater in the existing animal of 11 feet than in the fossil. The comparative measurement from the point of the muzzle to the maxillary extremity of the palatine bone, together with those across the skull at the 10th and 4th teeth, will point out in a still clearer way the bluntness and breadth of the muzzle of the fossil animal. By the extension of the intermaxillaries and the great length of the connecting suture between the point of the muzzle and the nasal aper-

[1] Brit. Mus, No. 39,801.—[Ed.]

Dimensions of Skull.

	Existing Crocodile				Fossil	
	11ft. long		7ft. long			
	Inches	Mètre	Inches	Mètre	Inches	Mètre
Upper Jaw—(Number of Teeth, 38)						
Length from point of muzzle to posterior extremity or margin of occipital condyle	17·1	0·435	11·3	0·286	—	—
Breadth on the temporal bones at the articulation with lower jaw	11·2	0·284	6·7	0·170	—	—
Ditto between the most prominent points of the alveoli of the 15th tooth	8·1	0·260	5·0	0·126	—	—
Ditto between ditto ditto 10th ditto	6·7	0·170	4·2	0·107	9·2	0·234
Ditto between ditto ditto 4th ditto	4·7	0·119	2·7	0·069	6·0	0·152
Length of intermaxillaries on suture below	3·2	0·0805	2·45	0·062	4·3	0·109
Ditto of maxillaries ditto	3·9	0·099	2·4	0·060	3·8	0·096
Length of palatine bones on the suture below	5·65	0·142	3·7	0·093	—	—
Ditto of sphenoid ditto	3.4	0·086	1·75	0·044	—	—
Extreme breadth across the pterygoid apophyses of sphenoid	7·2	0·182	4·4	0·112	—	—
Length from point of muzzle to anterior of orbit	11·5	0·290	7·3	0·186	—	—
Ditto ditto to ditto of lachrymal bone	8·4	0·211	5·5	0·140	—	—
Breadth of the frontal bone on its junction with lachrymal	1·9	0·048	1·1	0·027	—	—
Ditto on the posterior frontals at their junction with the mastoid bones	4·55	0·115	3·0	0·076	—	—
Length of external nostril or nasal aperture	2·05	0·052	1·40	0·035	3·1	0·079
Breadth of ditto ditto	1·7	0·043	0·95	0·024	2·8	0·070
Length of crotaphite foramina or those bounded by the poster. frontal, mastoid, and parietal bones	1·3	0·032	0·90	0·022	—	—
Breadth of ditto ditto ditto ditto	0·9	0·022	0·70	0·017	—	—
Breadth of occipital condyle	1·3	0·032	0·90	0·022	—	—
Ditto of occipital foramen	0·9	0·022	0·70	0·017	—	—
Depth of ditto	0·65	0·016	0·45	0·012	—	—
Diameter of 4th tooth upper jaw at its alveolus	0·5	0·014	0·30	0·008	1·0	0·026
Ditto 10th ditto ditto	0·85	0·021	0·42	0·010	1·15	0·029
Length from point of muzzle to maxillary extremity of palatine bone	7·05	0·180	4·8	0·122	7·9	0·20
Breadth of intermaxillaries on suture, i.e. between nasal aperture and point of muzzle	1·7	0·043	1·1	0·027	3·6	0·190
Width between grooves on upper jaw for receiving the 4th lower teeth	3·95	0·10	2·35	0·060	5·35	0·136
Lower Jaw—(Number of Teeth, 30)						
Length from muzzle to posterior extremity of articular bone	21·5	0·548	14·2	0·36	—	—
Extreme breadth at the articular bone	10·0	0·254	6·3	0·16	—	—
Breadth at the oval aperture formed by the junction of the three bones	11·7	0·296	7·1	0·18	—	—
Greatest depth of jaw	3·5	0·088	2·3	0·058	—	—
Length of symphysis	2·95	0·074	1·8	0·046	2·9	0·073
Depth of jaw between 8th and 9th teeth	1·55	0·039	0·9	0·022	—	—
Length of oval aperture at the posterior extremity of dental bone	1·85	0·048	1·1	0·027	—	—
Depth of ditto ditto	1·10	0·027	0·5	0·126	—	—
Distance between posterior extremity of oval aperture and posterior extremity of articular bone	6·55	0·167	4·0	0·102	—	—

ture, this aperture is thrown further back, so that a line drawn transversely through the grooves for receiving the 4th lower teeth (which in the existing animal would cut the *posterior* extremity), in the fossil passes through the *centre*, or rather in *front* of the centre of the nasal aperture.

The skulls of the true Crocodile and Cayman differ in the following points. 1. That of the Cayman is less oblong, shorter, and flatter at the muzzle. 2. The 4th tooth of the lower jaw enters into a hole in the upper; instead of a groove as in the true Crocodile. 3. They differ in the number of the teeth. 4. The cranial foramina bounded by the posterior frontal, mastoid, and parietal bones, are smaller, and sometimes altogether wanting in the Cayman. 5. The lachrymal and anterior frontal bones descend lower in the Crocodiles than in the Caymans. 6. In the Cayman a part of the vomer is visible in the palate between the maxillaries and the intermaxillaries. 7. The palatine bones advance more in the palate and are wider in front in the same animal. 8. The posterior nostrils are wider than they are long.

With regard to the cranial foramina of the fossil, and their proportion relatively to the surrounding bones, we are enabled, by having in our possession a very perfect fragment of the occipital region and that portion of the skull bounded by the orbits, to give the comparative measurements here also; noting that this fossil is a portion of the skull of an animal of much smaller dimensions than that from which the former measurements were taken.

	Existing Crocodile				Fossil Crocodile	
	11 feet long		7 feet long			
	In.	Mèt.	In.	Mèt.	In.	Mèt.
Length of crotaphite foramina .	1·30	0·032	0·9	0·022	1·40	0·036
Breadth of ditto	0·90	0·022	0·70	0·017	1·0	0·026
Breadth of the frontal bone on its junction with lachrymal .	1·9	0·048	1·1	0·027	2·1	0·053
Ditto on posterior frontals at their junction with mastoid bones .	4·55	0·115	3·0	0·076	4·85	0·122
Breadth of occipital condyle .	1·3	0·032	0·9	0·022	1·20	0·031
Ditto of occipital foramen . .	0·9	0·022	0·7	0·017	0·90	0·022
Depth of ditto	0·65	0·016	0·45	0·012	0·60	0·015

It will be observed from the above that the fossil and the existing animal of 11 feet very closely correspond in dimensions, although the crotaphite foramina are rather larger, and the width of the bones in their neighbourhood greater in the fossil than in the existing one. This proportional excess

of breadth, however, is not so striking as in the measurements of the muzzle before given; although it still bears us out in the general expanded dimensions of the fossil animal.

Of the lower jaw the only comparative measurement that our discoveries have enabled us to make is of a small portion of the anterior extremity, showing an extreme contraction and narrowness of the symphysis; that of the fossil being actually less than that of the existing 11 feet Crocodile. The form of the suture is similar in each, and the internal process equally well defined.

Further than from an inspection of the plates and description of the varieties of the Cayman and the Crocodile, in the 5th volume of the 'Ossemens Fossiles,' I am unacquainted with the form of any other head than that of the Crocodile which inhabits the Ganges and Jumna rivers in this part of India, and presume that I am correct in placing our existing animal amongst the Crocodiles '*à deux arrêtes.*' The peculiarities of the skulls in my possession resemble those of this species, although there is a point relating to the ridges which may as well be noted, more especially as the same feature is most prominently marked in the fossil, thereby assimilating our existing and fossil animal still more closely to each other.

The ridges (in *C. biporcatus*) are described as 'proceeding from the anterior angle of the orbit and descending in almost a parallel line along the muzzle, and gradually disappearing.' In both the fossil and existing specimens now under description the above note applies distinctly, with this exception, that the ridges partially disappear at a point half way on the nasal bones, from whence they strike off in an oblique direction right and left towards the alveoli of the 10th tooth, this oblique ridge showing itself as prominently as that at the anterior angle of the orbit.

There is a general resemblance between the fossil and the head of the existing Crocodile, which is striking. The rugosities and position of inequalities on the upper surface closely correspond; the cranial foramina, the number of teeth, the foramina in the upper intermaxillary bones for receiving the two front teeth of the lower jaw, the grooves for the 4th teeth of the lower jaw, and the general form of the nasal aperture, are features similar in both. We may therefore fairly conclude from analogy that the Crocodile now found fossil in the upper strata of the Sewaliks is of a species closely allied to the present one, with the simple difference of possessing greater width in its proportions: in which view we must be satisfied with establishing it as a

fossil variety of the *C. biporcatus* of Cuvier and the *C. porosus* of Schneider.

In taking the numerical proportion of the fossils already found as a guide to that of the animals existing on this tract previous to the upheavement of the line of country, it would appear that the Mastodon and Elephant were the most numerous. 2. Ruminants. 3. Hippopotamus of varieties, the largest of which, with six incisors (*H. Sivalensis*), is in the greatest proportion. 4. Crocodile, Ghariál, and Tortoise. 5. Rhinoceros, Hog, and Horse. 6. Carnivora. 7. Fish.

The remains of Saurian animals, although standing high on this list, consist chiefly of fragments of the osseous plates of the neck, vertebræ, detached teeth, articulating extremities of bones of the arms and legs, as well as other portions of the skeleton; while portions of the head have been rarely found. Those referred to in this note are very perfect; others are crushed and distorted; but the leading differences which have been adverted to aré fairly marked in all those that have come under my observation.

There appears to be a local disposition in the deposits of these remains, as would be natural to expect on a varied surface of plain, forest, and marsh. The Mastodons, Elephants, &c., in great abundance at some points, give place to the Hippopotami and Saurian reptiles in others. At many places the latter, with the Tortoise, are totally wanting; at others, as in a stratum of an impure marl attached to this upper series where freshwater shells (chiefly like the Unio of the present day) were found in great abundance, nearly the whole of the remains accompanying them were those of the Crocodile and Gharial. In considering the length of the fossil species we see no signs of anything beyond that of the animal now existing. The largest remain in our possession is a vertebra, which is one-third larger than that figured in the London Geological Society's 'Transactions' amongst the Ava fossils, and described as the remain of an enormous animal; the vertebra above mentioned is either one of the dorsal or lumbar, but the processes are broken and imperfect. The dimensions of the barrel or cylinder in this specimen, and the measurements of the third lumbar vertebra of the existing Crocodile, are here given:—

	Existing Crocodile 7 feet long		Fossil	
	In.	Mèt.	In.	Mèt.
Extreme length	1·4	0·036	4·9	0·124
Breadth under transverse apophysis, taking a mean measurement . .	0·95	0·024	3·5	0·089

Large as the fossil may appear, the animal to which it belonged did not in all probability exceed 25 feet in length, whereas the Gangetic Crocodile of the present day is said to arrive at the enormous length of 30 feet, and in the pages of the 'Calcutta Journal' an animal of 28 feet long is recorded as having been killed by a gentleman of the Civil Service (I believe) now residing in Calcutta.

The Fossil Gharial of the Sewalik Hills.

Amongst the numerous remains of the Crocodilean Saurians which have been found in such abundance, from the oolite up to the more recent strata, it would appear that the greatest proportion has been allied to the Gharial,[1] and that the existing Crocodile and Cayman have been almost without their prototypes. It is only in the strata above the chalk[2] at Montmartre, and the freshwater-formation at Argenton, where remains have been found which were considered by Cuvier as appertaining to the latter sub-genera; in these strata, however, the remains of animals of this description are scarce, and in those still more superficial abounding in the remains of the larger mammalia, in Mastodons, Hippopotami, &c., where we might naturally expect to find the Crocodile, the remains of this family have hardly I believe been found at all.

Of the fossil Crocodile brought by Crawfurd and Wallich from Ava, and figured in the London Geological Society's 'Transactions,' the drawings show a much nearer approach to the living congenera than had, up to the period of that discovery, been found; and although we are unacquainted with the geology of the country from which they were brought, the new varieties of the Mastodons, which appear to be common both to the Sewaliks and the Irrawaddi deposits, may establish an identity between the two formations.

In the Sewaliks we have upheaved alluvium, or débris from the great Himalayahs upheaved at a considerable angle; at those points especially between the Jumna and

[1] The French mode of writing this word, *Gavial*, appears to have originated in a misreading of the manuscript of some naturalist; the *r* and *v* being nearly similar in form. As *Gharial* is the correct native name, there seems no reason for perpetuating the misnomer.—J. Prinsep. Sec. As. Soc.

[2] In the London clay the remains of either the true Crocodile or Cayman with the concavo-convex vertebra are said to have been found, the species allied to *C. à museau aigu*, vide Parkinson Int. Org. Rem. p. 387, and also the head of an Alligator in the London clay of the Isle of Sheppey, found in 1832.

Ganges rivers, where the shingle and sand are the most developed, their appearance is similar to what we might imagine the beds of the present rivers to exhibit, were they to undergo a similar convulsion. The presence of the fossils has not been satisfactorily determined on the line between the Jumna and Ganges; those that have been already collected in such great abundance are from the prolongation of the same line between the Sutlej and the Jumna rivers. Up to the present time they have generally been collected from the slopes of the mountains, slips, water-courses, &c. They have been dug out near the village of Deoni, in the Nahun Rajah's territory, but at this spot the position of the stratum from which they were excavated was not satisfactorily determined. In the Ambwalla Pass, however, we had the satisfaction of finding a large fragment of bone *in situ*, in a stratum of sandstone rock, in the face of a cliff, terminating one of those tortuous little streams that drain the steep slopes of the mountains into the main channel. The sandstone stratum in which this was found was inclined as usual in an angle of from 20° to 30°; and the position of the fossil was perhaps 600 feet from the bed of the main river. In the present state of the inquiry this fact is interesting, for it appears that in the many slips that have been visited and most carefully examined, no fossils have been found actually *in* the rock, with the exception of the instances above mentioned. The fossils are evidently not confined to the sandstone; the clays and clayey conglomerates have their proportion also.

Of the Crocodile of these strata I have attempted in the preceding section to show, as far as measurements and my limited means point out, that the main difference between the fossil and the existing animal of the present rivers is in the breadth; a difference that might tend to an opinion of its being allied to the Cayman, did not other more distinct characters separate it at once from that sub-genus. In the Gharial now under review I am unable to recognize any difference from the living animal; and there are certain peculiarities about the external surface of the skull of the existing Gharial, in slight indentations and rugosities, which are singularly coincident with those of the fossil. The following measurements are taken from two recent skulls, one of an animal 10 feet 5 inches long, and the other 8 feet 8 inches long; and from a very perfect fossil skull with the beak broken off, which is evidently the remain of a large animal.

	Existing Gharial				Fossil Gharial	
	10ft. 5in. long		8ft. 8in. long			
Upper Jaw (Number of Teeth, 56)	In.	Mèt.	In.	Mèt.	In.	M ét.
Extreme length from point of muzzle to outer margin of occipital condyle.	22·7	0·577	19·5	0·495	—	—
Breadth on the temporal bones at the articulation with lower jaw	8·2	0·21	6·5	0·166	—	—
Ditto on the 28th tooth	4·3	0·108	3·4	0·086	9·3	0·236
Ditto on the 20th tooth	1·95	0·049	1·5	0·038	—	—
Length of intermaxillary on suture (below)	5·1	0·129	4·4	0·111	—	—
Ditto maxillaries ditto	8·8	0·223	7·9	0·200	—	—
Ditto palatine bone ditto	4·8	0·121	3·8	0·096	—	—
Ditto sphenoid ditto to anterior margin of the posterior nasal foramen	1·65	0·042	1·4	0·035	3·2	0·081
Extreme breadth on pterygoid apophysis of sphenoid	5·3	0·133	4·15	0·106	—	—
Length from tip of muzzle to anterior of orbit	16·4	0·416	16·4	0·366	—	—
Ditto ditto ditto of lachrymal bone	14·4	0·366	12·2	0·309	—	—
Breadth of frontal between orbits at the junction with the anterior frontal	2·4	0·060	1·95	0·049	4·9	0·124
Ditto of parietal bones between crotaphite foramina	0·55	0·014	0·65	0·016	1·0	0·026
Length of external nostril	1·1	0·027	0·85	0·021	—	—
Breadth of ditto	0·9	0·022	0·60	0·015	—	—
Length of crotaphite foramina, or those in rear of orbits	2·0	0·051	1·4	0·035	3·3	0·083
Breadth of ditto ditto	2·15	0·055	1·6	0·040	3·8	0·096
Ditto of occipital condyle	1·2	0·030	0·95	0·024	2·5	0·064
Length of occipital foramen	0·9	0·022	0·80	0·020	1·4	0·035
Depth of occipital foramen	0·65	0·016	0 45	0·012	0·9	0·022
Length of palatal sinus	2·65	0·068	2·35	0·059	4·9	0·124
Breadth of ditto	1·4	0·035	1·10	0·046	2·4	0·060
Length from point of muzzle to anterior extreme of palatine sinus	16·45	0·418	14·2	0·361	—	—
Length of upper table of cranium between the anterior margin of the orbits and the posterior mastoid apophysis	5·8	0·147	4·7	0·120	10·4	0·264
Breadth of ditto ditto ditto	6·0	0·152	4·7	0·120	11·4	0·289
Lower Jaw (Number of Teeth, 50)						
Length of symphysis	15·1	0·384	13·1	0·332	—	—
Ditto on prolongation to posterior extreme of articular bone.	10·7	0·271	9·3	0·236	—	—
Breadth on articular bones	8 6	0·218	5·8	0·147	—	—
Ditto on 23rd tooth	3·0	0·076	2·5	0·064	—	—
Ditto 15th ditto	1·6	0·040	1·3	0·032	—	—
Ditto 3rd ditto	1·55	0·039	1·3	0·032	—	—
Ditto 2nd ditto	1·85	0·047	1·6	0·040	—	—
Ditto 1st ditto	1·4	0·035	1·2	0·030	—	—
Length of oval hole at posterior extreme of dental	1·35	0·034	1·3	0·032	—	—
Depth of ditto	0·6	0·0155	0·45	0·012	—	—
Ditto of jaw on this oval hole	2·0	0·050	1·5	0·038	—	—
Ditto on the 15th tooth	0·9	0·022	0·7	0·017	—	—

This fossil is water-worn, and some of the projecting bones, especially of the sphenoid, are mutilated at the extremities; but the general character of the head and the form and position of the foramina, &c., appear to correspond completely with those of the existing Gharial.[1]

There is no approach to any of the peculiarities pointed out by Cuvier in the Caen and other fossils. On the upper surface we have, in the frontal, the same concavity between the orbits; the same form of the crotaphite foramina, with the parietal surface between them of the same comparative width; the posterior frontal separating the orbit from the crotaphite foramina corresponds; the form of the mastoid bones, both in themselves and at their articulation with the apophysis of the os tympani, strictly agree with the existing Gharial of the present rivers. The same may be said of the lateral and lower faces, in the external widening out of the pterygoid apophyses in the situation of the hinder nasal fossa, in the elevation of the orbital edge of the frontal, with the deep emargination, in the form and proportions of the jugal, and the temporal fossa, and in the sharp elongated internal process of the squamous bone: the form of the palatine holes, and the relative situation of the teeth to these holes, are also points which agree with the living animal!

The animal to which this fossil belonged was not quite 20 feet long; the complete head, from the tip of the muzzle to the posterior margin of the occipital condyle, being about 47 inches. The measurements which I have made of the existing Gharial show the proportion of the head to the length of the animal as 1 to $5\frac{1}{2}$.

The following measurements of another fragment, consisting of the anterior extremity of the beak or muzzle of the upper jaw, will still further go to establish the resemblance.[2]

	Existing Animal				Fossil	
	10ft. 5in. long		8ft. 8in. long			
	In.	Mèt.	In.	Mèt.	In.	Mèt.
Length of intermaxillary on suture below	5·11	0·129	4·4	0·111	8·30	0·210
Breadth on 9th tooth	1·55	0·038	1·25	0·031	2·70	0·069
Ditto 4th ditto	2·00	0·050	1·60	0·040	3·40	0·086
Ditto 3rd ditto	2·20	0·055	1·80	0·046	4·00	0·101
Ditto 1st ditto	0·70	0·017	0·60	0·015	1·40	0·035
Depth on 9th tooth	0·90	0·022	0·70	0·017	1·40	0·035

The above is the remain of a smaller animal than the

[1] Brit. Mus. Cat., No. 40,206.—[Ed.]

[2] Brit. Mus. Cat., No. 39,811.—[Ed.]

former one, showing the alveoli and some of the teeth, as far back as the 10th, on each side of the maxillaries. A more perfect resemblance to the living animal than this could not well be conceived; and it moreover establishes, in the absence of a connected beak and skull, that the fossil animal had precisely the same number of teeth with the living species. The suture connecting the intermaxillaries with the maxillaries is fortunately strongly marked in the fossil; the posterior point of the suture occurring opposite the ninth tooth, exactly as it does in the existing animal. The teeth, the form of anterior extremity of muzzle, the outer nasal aperture, with the lower indentations, correspond in every way; and, to descend still further to minutiæ, at the commencement of the suture connecting the intermaxillaries and maxillaries, at a point in the former bone immediately in front of the sixth tooth, is a small hollow or indentation; this hollow exists in the same situation and bears the same form in our fossil Gharial.

Of the lower jaw we have only an imperfect fragment of the two branches connected at the commencement of the symphysis; from the extreme hardness of the crystalline rock in which it is embedded we are unable to see further than that the angle of these branches corresponds with the existing animal, a point however which is proved by the fragments of skull which are in our possession, and which, imperfect as they are at the muzzle extremity, show distinctly the commencement of that tapering form which is peculiar to the Gharial of the present rivers.

In volume v. of the 'Ossemens Fossiles,' Cuvier, in recapitulating the peculiarities and differences between the Crocodiles and Gharials, says of the latter: 'Les ptérygoïdiens forment au-dessus des palatins des espèces de grosses vessies renflées et ovales de la grosseur d'un œuf de poule, au lieu d'une simple voûte cylindrique comme dans les crocodiles et les caïmans,' &c., and then, 'Je n'ai point observé cette vessie dans le petit Gavial, mais je suppose d'autant plus qu'elle est un produit de l'âge, que dans les vieux crocodiles des Indes cet endroit est beaucoup plus renflé que dans les jeunes.'

These demi-cylindrical swellings are highly developed in the 10 feet 5 inches specimen, of which the measurements have been given; whereas in the smaller and younger animal, measuring 8 feet 8 inches, there is no appearance of them; the sphenoid portion lying under the palatine and extending up to the anterior frontal's apophysis, in a flat uninflated laminated bone. From the little difference that exists between the bones of the Gharial and of the Crocodile,

DESCRIPTION OF PLATE XXIX.

CROCODILUS CRASSIDENS, CROCODILUS LEPTODUS, AND LEPTORHYNCHUS GANGETICUS.

The figures in this Plate have been drawn by Mr. Dinkel from the original specimens in the British Museum, which have been identified with outline tracings named by Dr. Falconer.

Fig. 1. Profile view of skull and lower jaw of *Crocodilus crassidens*, an extinct species found in the Sewalik Hills. The specimen bears the number 39,802 in the British Museum Catalogue, and is drawn one-sixth of the natural size. (See pages 297 & 355.)

Fig. 2. Is another specimen of a fragment of cranium of the same species (*C. crassidens*), showing the palate surface and teeth. It is numbered 39,803 in the British Museum Catalogue, and is drawn one-sixth of the natural size.

Fig. 3. Shows a portion of the cranium, the palate, and teeth of the elongated muzzle of *Crocodilus Leptodus*, an extinct species found in the Sewalik Hills. The figure is drawn one-sixth of the natural size, and the specimen is numbered 39,805 in the British Museum Catalogue. (See page 355.)

Fig. 4. Another fragment of muzzle of *Croc. Leptodus*, drawn one-fourth of the natural size. (Brit. Mus. Cat. No. 39,806.)

Fig. 5. Very perfect specimen of anterior portion of muzzle of *Leptorhynchus Gangeticus*, an existing species (the Gavial) found fossil in the Sewalik Hills. The specimen has been drawn one-fourth of the natural size, and is numbered 39,811*a* in the British Museum. The artist has represented the under surface of the muzzle instead of the upper. The latter shows well the characteristic external nasal aperture. The corresponding specimen described in Capt. Cautley's memoir is numbered 39,811. (See page 353.)

Fig. 1.

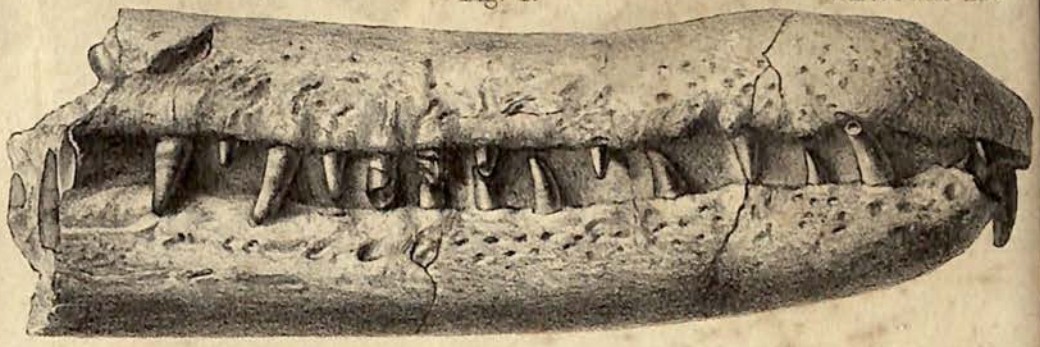


Fig. 2.

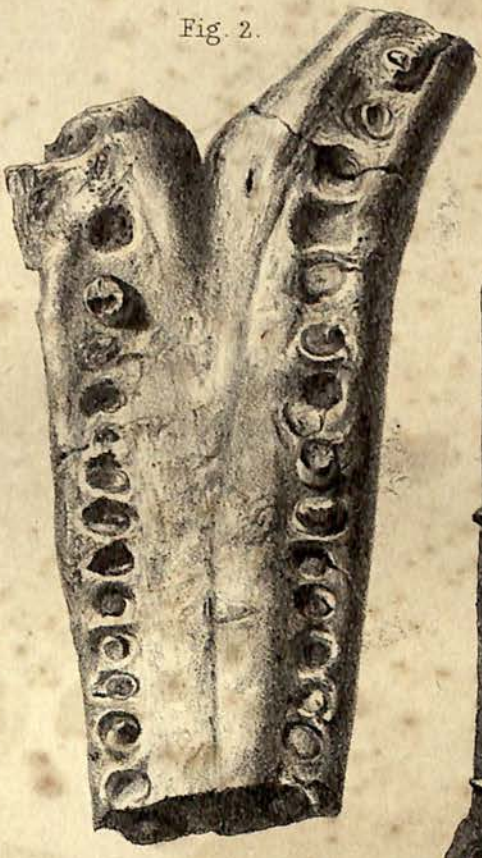
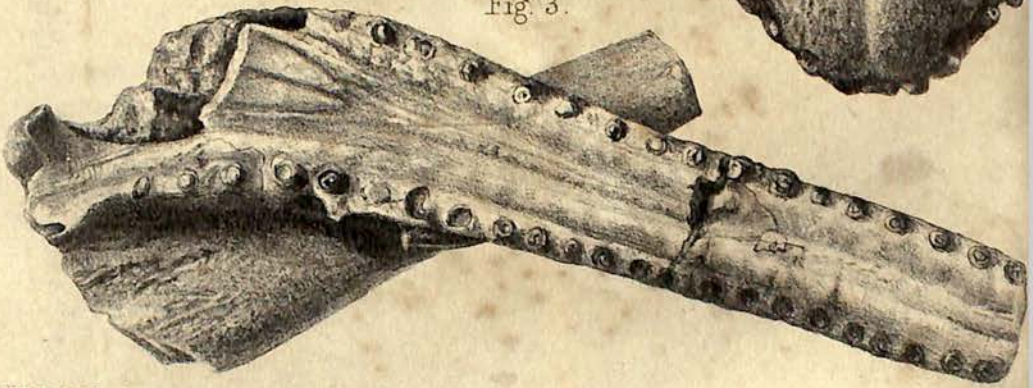


Fig. 4.

Fig. 5.

Fig. 3.



J. Dinkel del. et lith. W. West imp.

1, 2. Crocodilus crassidens. 3, 4. C. Leptodus. 5. Leptorhynchus Gangeticus.

we are unable to separate the remains of one from those of the other. A great quantity have been found—teeth, osseous plates, ribs, vertebræ, &c.; the latter having the concavo-convex body, and the sacral vertebræ, with their transverse processes compressed and cylindrical, agree in every respect with the existing animal.

NORTHERN DOAB: *October* 1, 1835.

APPENDIX TO MEMOIR ON CROCODILES.

I.—NOTE BY EDITOR.

Subsequent investigations in the British Museum and elsewhere caused doubt in Dr. Falconer's mind as to the correctness of the identifications by Capt. Cautley in the above memoir. This is indicated by the following passage from a letter dated London, Jan. 5th, 1844, addressed to Capt. Cautley in India :—

'Our Crocodile of the Upper Provinces is not the *C. biporcatus* of Cuvier—of that I am certain. There appear to be three existing Indian species of Crocodile, as distinct from Gavial, viz.: *C. biporcatus*, with a long sharp head; *C. palustris*, with a shorter and broader head; and *C. bombifrons*, undescribed, very short and blunt. Of these, the head figured by you and given with dimensions in the "Asiatic Researches," appears to me to be *C. bombifrons*, undescribed, but so named in the British Museum.'

The following extracts, however, from letters also addressed to Capt. Cautley, show that Dr. F. had no doubt as to the identity of the fossil with the existing Crocodile and Gharial :—

Aug. 5th, 1843. 'He (Mr. L.) doubted my confident assertion that our fossil Gavial was identical with the existing species.'

Dec. 6th, 1843. 'I gave C. a flat contradiction on his saying that existing species of Crocodile had been found before, with extinct genera of animals. This in reference to our assertion of the fossil Crocodiles being recent species.'

Four species of Crocodile among the Sewalik fossils were afterwards determined by Dr. Falconer in the British Museum, viz.: *Crocodilus bombifrons; Croc.* (*Leptorhynchus*) *Gangeticus; Croc.* (*Leptorhynchus*) *Leptodus; and Croc.* (*Leptorhynchus*) *crassidens.* The two first are identical with existing species. The last was described, in 1837, as 'an immense species, far exceeding existing ones, and forming a passage from the Gavials into the true Crocodiles. It has the cylindrical muzzle and synostorized lower jaw of the former, with the blunt, thick teeth of the latter.' See *antea*, page 297.

Outline figures of these species, found among Dr. Falconer's papers, have been identified with the specimens in the British Museum; and from these specimens the illustrations in Plates XXVIII. and XXIX. have been drawn by Mr. Dinkel.—[ED.]

II.—Memoranda on the Belfast Crocodiles. From Dr. Falconer's Note-book, May 22, 1845.

Made a comparison with Thompson of the Belfast specimen of the long-muzzled Crocodile head, procured by Dr. McCormac from the river Sierra Leone. This specimen certainly belongs to the *Crocodilus cataphractus* of Cuvier. It corresponds exactly with the description of the *Crocodilus cataphractus* given by Dumeril and Bibron, in the number of teeth, form of the head, muzzle, &c. Compared it with the figures of *Crocodilus Schlegelii* given in Müller's Atlas. It comes pretty near this, but is certainly different, having fewer teeth in both jaws, and the commissure of the lower jaw being much shorter in proportion than in the *C. Schlegelii*. It is more of a Crocodile than the *C. Schlegelii* which comes nearer the Gavial. The nasal bones in both join with the intermaxillaries, but in the *C. Schlegelii* the slips of the intermaxillaries run higher up between the maxillaries: and the lateral outline in *C. Schlegelii* is more cylindrical, being strongly undulated in *C. cataphractus*. The *Crocodilus cataphractus* is evidently identical with the *Mecistops Bennettii* of Gray. The Belfast specimen corresponds very closely in size with the stuffed specimen in the British Museum. The head is about 17 inches long; the extreme breadth at the condyles, 7 inches; do. behind the orbits, $4\frac{3}{4}$ inches; do. in line with anterior border of do., $3\frac{1}{2}$ inches; do. at seventeenth or last tooth, $3\frac{5}{8}$ inches. This last tooth extends to within $\frac{1}{4}$ inch of the orbit. The muzzle contracts between the eleventh and twelfth teeth to $1\frac{3}{4}$ inch; it then expands to 2 inches opposite the ninth teeth, which are the largest in the head. From the ninth it goes on contracting to the space between the fourth and fifth (this interval being $\frac{3}{4}$ inch) where it gets contracted to 1 inch. At the extremity of the muzzle, between the second and third, it expands to $1\frac{3}{4}$ inch.

Its detailed dimensions are as follows:—

	Inches
1. Length from the tip of the muzzle to the occipital ridge	15·5
2. Length from ditto to maxillary condyle	17·
3. Extreme width of cranium at condyles	7·
4. Interval between the orbits	0·75
5. Length from the occipital ridge to the extremity of the nasals	6·
6. Length from tip of muzzle to ditto	9·
7. Length of orbit	1·88
8. Width of ditto	1·37
9. Length of crotaphite foramen	1·12
10. Width of ditto	0·88
11. Width of muzzle at the tip of nasals	2·75
12. Ditto at 9th tooth	2·
13. Ditto of contraction behind 4th tooth	1·12
14. Width of dilatation of muzzle	1·88
15. Length of nasal opening	0·88
16. Width of ditto	0·75
17. Number of teeth in the upper jaw, 17.	
18. Largest teeth in upper jaw, 3rd and 9th.	
19. Length of intermaxillary bone at the palate	3·
20. Length of maxillary ditto	6·25
21. Number of teeth in lower jaw, 15.	
22. Largest teeth in lower jaw, 1st, 4th, 10th, and 11th.	

III.—Memorandum by Dr. Falconer on Crocodilus Schlegelii.

The *Crocodilus Schlegelii* is not a true Gavial, but a Crocodile. 1. The cranial tablet, instead of being square to behind the orbits converges on either side. 2. The crotaphite foramina are smaller than the orbits considerably. 3. The nasals descend so as to join on with the long wedge apophyses of the intermaxillaries, whereas in the Gavial they are separated, and are a third of the entire length of the muzzle. The cranial tablet in *C. Schlegelii* has very much the form as in the figure of *C. lucius* in Cuvier's 'Ossemens Foss.' 4. The upper wedge-shaped terminations of the intermaxillaries are larger and more slender than in Gavial. 5. The outer border of the orbits do not overhang the maxillaries as in the Gavial, but are within them as in the Crocodiles. 6. The greatest diameter of the orbit is not transverse as in Gavial, but lengthwise, and the form is very much as in *C. biporcatus*. 7. There is no considerable contraction behind the fifth tooth of the muzzle in the upper jaw as in Gavial, and no appearance of the great enonarrhine cartilaginous sac of Gavial. In *C. Schlegelii* the anterior ends of the palatines terminate in a line with the great palatine holes, while in the Crocodiles they descend in slips between the palatine portion of the maxillaries, as also in the Gavial.

The form of *Croc. Schlegelii* agrees very closely with that of *C. Journei*, described by Bibron and Dumeril. In *C. Schlegelii* there are twenty teeth in the upper jaw and nineteen or twenty in the lower. In *C. Journei* there are eighteen in the upper and only fifteen in the lower. The length of head in an old *C. Schlegelii* is to its greatest width as $2\frac{1}{3}$ to 1, which is exactly the same proportion as in *C. Journei*. Width at anterior border of orbits $\frac{1}{4}$ nearly in *C. Schlegelii*, and $\frac{1}{4}$ in *C. Journei*; opposite ninth tooth in *C. Schlegelii* $\frac{1}{6}$ to $\frac{1}{7}$, in *C. Journei* $\frac{1}{6}$ at tenth tooth; tip of muzzle in *C. Journei* $\frac{1}{8}$, in *C. Schlegelii* $\frac{1}{8}$ to $\frac{1}{9}$. (But the dimensions of muzzle in *C. Schlegelii* vary with the age. The muzzle is longer in proportion to its diameter in the young than in the old animal.) The longest teeth in *C. Journei* are the first, fifth, and tenth, in upper jaw, and the first and fourth in lower. In *C. Schlegelii* they are the first, fifth, and ninth, in upper jaw, and the first and fourth in lower.

IV.—Descriptions by Dr. Falconer of Fossil Remains of Crocodiles, from Ava, Perim Island, and the Nerbudda, in the Catalogue of the Museum of the Asiatic Society of Bengal.

The following from the Sewalik hills are most noteworthy [Ed.]:—

No. 642. *Leptorhynchus Gangeticus.*—Fine fragment of cranium without the lower maxilla, deficient only from the muzzle portion in front of the orbits; the whole of the occipital region with the occipital condyle nearly entire. The transverse articular surface of the tympanic bone and a part of the squamous portion adjoining removed; the cranial tablet perfect, as also the two crotaphite foramina, together with both orbits; palatines shown underneath, but pterygoids broken off. The alveoli of only three small teeth shown on the broken part of the right maxilla. The contraction of the muzzle, the form of orbits, their elevation above the frontal, the cranial tablet, and the form and proportion of the crotaphite foramina to orbits and the other adjoining parts,

correspond so exactly in every respect that no determinable difference is perceivable. The skull is larger than that of a Gavial's head, which measures 19 in. The specimen infiltrated with iron and very heavy.

No. 652. *Leptorhynchus.*—Fragment of muzzle-portion of lower jaw of an enormous-sized animal; the left side showing the empty alveoli of the five anterior teeth of very large size, broken off obliquely backwards; the right side broken off nearly opposite the termination of the last alveolus on the left side and continued backwards, showing the alveoli of five teeth, four of which contain more or less of the teeth, its anterior portion wanting.

Dimensions.

	Inches
Length of fragment	13·5
Width about middle	9·5
Thickness	4·6

The alveoli of the two first teeth are very large; the third and fourth are still larger, the third showing a diameter of 1·8 in. by 1·4 in.; the sixth tooth is smaller, being 1 in. in diameter; the seventh is 1·4 by 1·2 in. in diameter; the eighth and ninth are smaller.

Marked 'Fossil Alligator' in J. Prinsep's hand-writing; no other mark or No.; but vol. v. p. 180 of Jour. As. Soc. contains a notice of a Crocodile of gigantic size with a cylindrical muzzle, and with teeth projecting three inches above the jaw and one inch two lines in diameter.

No. 653. *Leptorhynchus.*—Portion of lower jaw left side, comprising a part of the horizontal ramus behind the symphysis, and containing the alveoli of two teeth. The suture of the opercular bone is visible; alveoli of enormous size, the anterior being about 1 in. 5 lines in diameter.

	Inches
Height of jaw taken opposite last tooth	6·7
Thickness of ditto	5·6
Length of fragment	10·5

Probably belongs to an animal of corresponding size with 652, but it differs in weathering and colour of surface.

XX. ON THE COLOSSOCHELYS ATLAS, A GIGANTIC TORTOISE FROM THE SEWALIK HILLS.[1]

I.—On some Remains of the Megalochelys Sivalensis, a gigantic Tortoise from the Tertiary Strata of the Sewalik Hills.[2]

BY H. FALCONER, M.D.

The class of Reptilia has been prolific in colossal and surprising forms, beyond all others; nor are its wonders at an end. Year after year has continuously added something new, till air, land, and sea have alike vindicated by their representatives the pre-eminence of Saurians above all other monsters. The Iguanodon of Europe had not ceased to create astonishment by the vastness of its dimensions, when the Basilosaurus of America comes forth to claim a higher rank, and exhibit a reptile still more enormous; and, when the fossiliferous deposits of the tropics shall have unfolded their contents, something still more may be produced.

The analogy of nature would *a priori* lead to the presumption that gigantic types of the Chelonian reptiles must have formerly existed, as well as Saurian ones. We see the existing species extending through the same range of habit and organization, some carnivorous and some herbivorous, some marine or fluviatile and others terrestrial. The same analogy would lead us to infer that the largest types would be found among the terrestrial and herbivorous groups, as this holds among the Saurians. But, so far as we know, no very immense *Testudinata* have hitherto been discovered, although such might have been expected to be associated with the Iguanodon and Megalosaurus. So much is it the reverse, that the *Emydes* and *Trionyches* of the strata which have

[1] Unfortunately no complete memoir on the *Colosscochelys* was ever published, and there are no drawings of this remarkable fossil in the 'Fauna Antiqua Sivalensis.' The documents, however, now brought together remedy in a great measure this defect. The remains of this gigantic tortoise are preserved in the British Museum, where there is also a restoration of the shell. The illustrations in Plates xxx. and xxxi. have been drawn by Mr. Dinkel, from the specimens in the British Museum.—[Ed.]

[2] This memoir was commenced about 1837, but was never finished. The fossil, however, was referred to under the designation *Megalochelys Sivalensis*, in Journ. Asiat. Soc. vi. 358, 1837. The name was afterwards changed to *Colossochelys Atlas*, 'as the term "Megalochelys" was thought not to convey a sufficiently expressive idea of the size.' [Ed.]

yielded these are not larger than existing species of the same genera. The largest remain on record, within our means of knowing, is mentioned by Cuvier,[1] as a radius of a sea-turtle which indicated an animal with a buckler eight feet long, procured from the quarries near Luneville, of the age of the jurasic limestone.

In a previous communication[2] we intimated our having become possessed of bones of the extremities, with corresponding fragments of bucklers, of a Chelonian from the tertiary deposits of the Sewalik hills, as large as the corresponding bones of the Indian Rhinoceros. These form the subject of the present notice.

The most perfect specimen comprises somewhat less than the upper half of the left humerus, and is, so far as it goes, very completely preserved. The articulating head, except where splintered by the chisel, is entire, and so also are the two great crests. The dimensions are:—

	Inches
1. Extreme length of the fragment	14·4
2. Greatest diameter from the convexity of the articulating head to margin inner tuberosity	9·7
3. Length of the inner tuberosity, from where it rises from the shaft of the bone	10·4
4. Greatest width of ditto from its outer margin to the border of the neck	5·2
5. Projection of ditto above the level of the articulating head	2·5
6. Greatest diameter of articulating head	5·1
7. Transverse ditto between the roots of the crests	4·5
8. Antero-posterior diameter of the shaft where broken across	3·1
9. Transverse ditto ditto	3·5
10. Width of smaller crest	6·9

The humerus and femur of the *Testudinata* are so much alike that it is difficult to distinguish them, except by the lower end. Our specimen we make out to be a humerus, and it is of some importance to ascertain this point in estimating the size of the animal:—1st. From the form of the inter-tubercular hollow, which has a ridge across dividing it into two fossæ: this is peculiar to the humerus. 2nd. By the spherical form of the articulating head, which in the femur is oblong. 3rd. By the smaller crest, which runs partly across the direction of the articulating head, exactly as in the humerus of the *Emydes*. It differs from the humerus of any of the known sub-genera of the family. In the land-tortoises the deltoid crest hardly rises above the level of the articulating head; and the smaller crest reaches only as high as the inferior level; the fossil is strongly contrasted in both respects. In Chelys and Trionyx the crests are wide apart, so as in the former to point in opposite directions with the same plane. In the fossil they are approximated, and partly

[1] Ossemens Fossiles, tom. v. part ii., p. 525.

[2] On the remain of a fossil Monkey. [See *antea*, p. 297.—Ed.]

parallel. The humerus of the sea-turtles is so peculiar as to have no analogy with the fossil except in the olecranon-like production of the deltoid crest.

It has more resemblance to the Emys, or the box-tortoises, than to any of the others. The two crests are approximated in both—as also in Testudo, and the smaller crest in both reaches half way up, and well across the articulating head. With this resemblance, however, it differs sufficiently. The deltoid crest is greatly more developed than in Emys; it is more pointed upwards, and projects more; and runs down with a convex outline where it falls off in Emys. This convexity and pointed form of crest is not seen in any of the existing *Testudinata*. The articulating head is very globular, the greatest diameter being 5·1 inches, and across between the roots of the crests, 4·5. Calculated on the proportions of a small Emys, the dimensions would give a buckler of 12 feet in length. We possess similar fragments of the right humerus and a femur; but the crest and articulating head are broken off, and have no character for description.

Of the bucklers we have a great variety of fragments; some of them indicating animals of prodigious size, but it is difficult to make anything intelligible out of them, as the ribs and plates of the plastron have become completely synostosed, and afford no trace of suture. But some of them are sufficiently distinct to show that the animal to which they belonged differed remarkably from all known *Testudinata*. One of these, which we consider to be the caudal extremity of the plastron, has a wide and deep re-entering angle between two projecting horns. The only thing approaching this is the slight emargination of the plastron in Emys.

Some other pieces are very remarkable. They rise out of the inner surface of the shield and project beyond its margin with a rugged and gradually thinning convex edge, like the ribs of Trionyx. The dimensions are:—

	Inches
Width of the rib-like extremity	8·2 and 8·6
Greatest thickness	5·5 and 4·2
Least thickness where hollowed out	0·8

Supposing them to be ribs, which, however, is by no means certain, what prodigious animals must they not have come from? But when we are certain of such large tortoises as those indicated by the humerus described, it were easy to imagine others with humeri as large as those of the largest mastodons. The surface of the shield-plates in all the great fragments is rough and loosely cancellated, like the interior structure of the articulating heads of bones. There is none of the shagreening of Trionyx, nor of the smooth surface of Emys.

To what description of *Testudinata* do the humerus and

these bones belong? This is a question not easily to be solved at present. The characters of the humerus would determine the animal to have been allied to Emys and Testudo; but on the ragged edge of the buckler fragments, as described above, we see every appearance of the attachment of a soft substance, and the resemblance is very strong to Trionyx. It would appear that part of the case was cartilaginous, as in that genus, and not completely ossified. Some large fragments have the character of a line of marginal plates, which would separate them at once from Trionyx, and possibly the cartilaginous parts were confined to the plastron.

II.—On the Osteological Characters and Palæontological History of the Colossochelys Atlas. Abstract of an Extempore Communication to Zoological Society of London, March 26th and May 14th, 1844.[1]

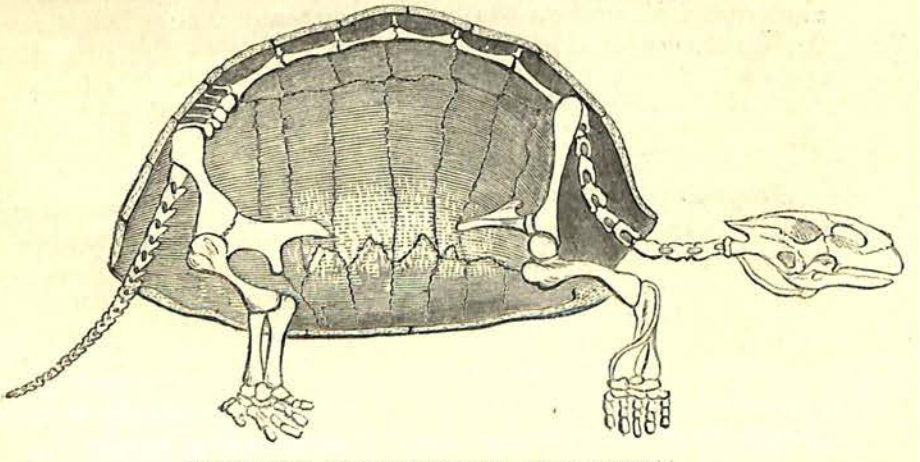
BY H. FALCONER, M.D.

Part I.

A communication was made by Dr. Falconer, conveying the substance of a paper by Captain Cautley and himself on the osteological characters and palæontological history of the *Colossochelys Atlas*, a fossil tortoise of enormous size, from the tertiary strata of the Sewalik hills in the north of India —a tertiary chain apparently formed by the detritus of the Himalayah mountains.

A great number of huge fragments derived from all parts of the skeleton except the neck and tail were exhibited on the table, illustrative of a diagram by Mr. Scharf of the animal restored to the natural size. (See Fig. 12.)

Fig. 12.



RESTORATION OF COLOSSOCHELYS ATLAS, REDUCED.

[1] Reprinted from Proc. Zool. Soc. Lond. 1844, Part xii. pp. 54 and 84.

The communication opened with a reference to the reptilian forms discovered in the fossil state, among which colossal representatives have been found of all the known tribes, such as the *Iguanodon, Megalosaurus, Labyrinthodon,* &c., besides numerous forms of which no living analogues exist, such as the *Enaliosaurian* reptiles and *Pteroddctyles.* No fossil *Testudinata* remarkable either for size or deviation from existing forms have hitherto been found in the fossil state. The *Colossochelys* supplies the blank in the first respect, while it differs so little from the land-tortoises in the general construction of its osseous frame, as hardly to constitute more than a sub-genus of *Testudo.*

The plastron or sternal portion of the shell affords the chief distinctive character. The episternal portion in the adult is six and a half inches thick, and contracted into a diameter of eight inches, bifid at the apex, and supplied with a thick cuneiform keel on its inferior surface; this keel constitutes one of the principal features in the fossil. The entosternal portion exhibits exactly the form of *Testudo,* the same being the case with the xiphosternal or posterior portion. The plastron in the adult animal was estimated to be nine feet four inches long. (See Plates XXX. and XXXI.)

The carapace or buckler of the shell coincides exactly with the general form of the large land-tortoises, of which it exhibits only a magnified representation, flattened at the top and vertical at the sides, with the same outline and recurved margin. The shell was estimated to have been twelve feet three inches long, eight feet in diameter, and six feet high. The head was estimated to have been two feet long, and the whole animal upwards of 20 feet.

The extremities were described as constructed exactly as in the land-tortoises, in which the form of the femur and humerus is marked by peculiar characters. These bones in the fossil were of a huge size, corresponding to the dimensions of the shell. The ungual bones indicated a foot as

[1] On a slip of paper Dr. Falconer draws the following comparison between the *Testudo elephantopus,* in the College of Surgeons, and the *Colossochelys Atlas.*

	Test. eleph.	Coloss. Atlas.
From the episternal to end of entosternal	10 inches	2 feet 11 inches
Length of plastron	32 „	9 „ 4 „
Length of carapace	42 „	12 „ 3 „
Ditto along the curve	54 „	15 „ 9 „

The following calculation is then made as to the total length of the *Colossochelys*:

	Feet	In.
Length of carapace	12	3
„ neck	6	0
„ head	2	0
„ tail	2	0
Total . . .	22	3

[Ed.]

large as that of the largest Rhinoceros. The humerus was more curved, and the articulating head more globular and deeper in the fossil, from which it was inferred that it had a stronger articulation and greater rotation, and that the *Colossochelys* was enabled to bring its anterior extremities more under its weight than is the case with existing tortoises.

The affinities with *Testudo* shown in the shell and extremities were found to hold equally good in the construction of the head, of which a comparatively small-sized specimen, inferred to have belonged to a young or half-grown *Colossochelys*, was exhibited. The head of the adult to correspond with the dimensions of the shell, and according to the proportions furnished by a large *Testudo Indica*, was deduced to have been two feet long.

There were no ascertained cervical vertebræ to afford direct evidence as to the length of the neck, which was constructed in the diagram relatively to the proportions of *Testudo Indica*. The entire length of the *Colossochelys Atlas* was inferred to have been about eighteen feet,[1] and it was believed to have stood upwards of seven feet high.

The generic name given by the discoverers has reference to the colossal size of the fossil (*κολοσσός* et *χέλυς*), and the specific one to its fitting representation of the mythological tortoise that sustained the world, according to the systems of Indian cosmogony.

The anatomical details occupied so much of the evening, that space was not left for Dr. Falconer to enter on general points connected with the fossil, such as its possible connection with the mythological fables of the Hindoos and the æra of its extinction, which will form the subject of another communication.

The results of a chemical analysis of the bones by Mr. Middleton were communicated, showing that they contained a very large quantity of fluorine. Some rough sketches of the *Colossochelys* were exhibited, etched on glass by means of the fluorine yielded by its own bones. The analysis indicated the presence of 11 per cent. of fluoride of calcium.

Part II.

On a former meeting we went through the anatomical characters presented by the remains of the *Colossochelys Atlas*. Commencing with the plastron, we traced the modifications of form through the costal elements of the carapace and the dorsal vertebræ, all of which bear the closest resemblance to the ordinary type of the Chersite Chelonians, or

[1] See note, p. 363.—[Ed.]

DESCRIPTION OF PLATE XXX.

COLOSSOCHELYS ATLAS.

The figures in this Plate have been drawn by Mr. Dinkel from the original specimens in the British Museum.

Fig. 1. The bifid episternum of *Colossochelys Atlas*, seen from the under surface, showing the thick cuneiform keel. The specimen has been drawn one-sixth of the natural size, and bears the number 40,630 in the British Museum Catalogue. (See pages 363, 374, & 378.)

Fig. 2. Shows the xyphosternal or posterior portion of the plastron of *Colossochelys Atlas*, one-sixth of the natural size. The posterior cleft is well seen. The specimen is numbered 40,629 in the British Museum Catalogue. (See pages 363 & 378.)

Figs. 3, 4, and 5. Represent three different views of one of the ungual bones of *Colossochelys Atlas*, drawn one-half of the natural size. Brit. Mus. Cat. No. 36,731. (See pages 364, 374 & 381.)

Fig. 1.

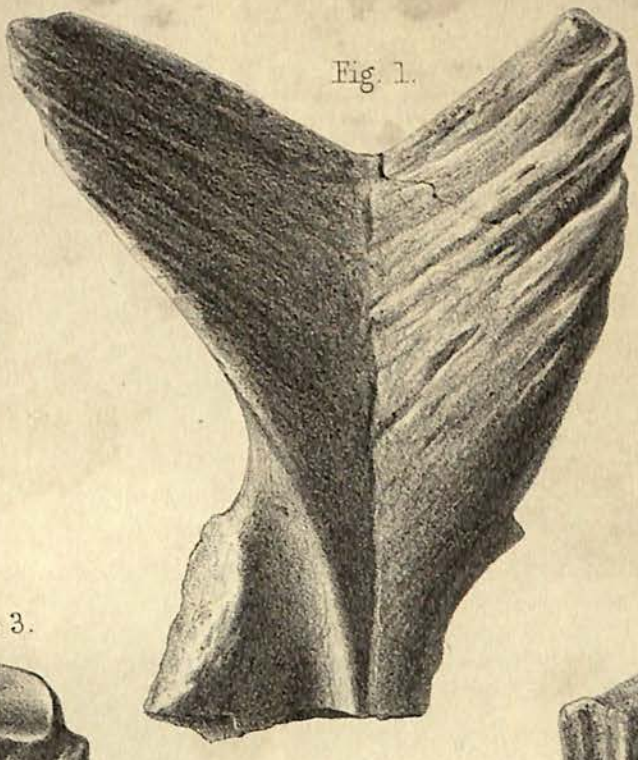


Fig. 3.

Fig. 4.

Fig. 2.

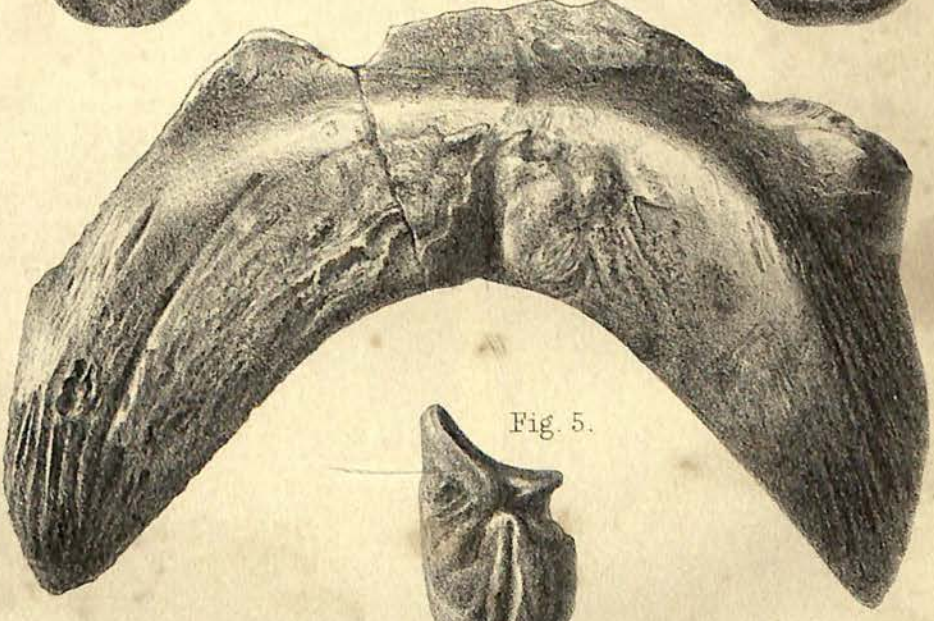


Fig. 5.

true land-tortoises. A like result followed the examination of the extremities, which, as exhibited in the remains of the humerus, femur, and ungual phalanges, were seen to be constructed exactly on the plan of *Testudo*, with columnar legs and truncated club-shaped feet, as in the proboscidean Pachydermata. The same direction of affinity was observed throughout the confirmation of the head. The only portions of the skeleton from which more or less direct evidence was not derived were the neck and tail vertebræ, of which there were no specimens in the collection. The general result of the examination showed that the *Colossochelys Atlas* was strictly a land-tortoise in every part of its bony frame; and the impressions of the horny scutes proved the like in regard to the arrangement of its dermal integument.

The principal distinctive characters were found in the sternum, which is enormously thickened at its anterior extremity, along the united portion of the episternal bones, and contracted into a narrow neck, so that the width of the combined episternals does not much exceed their thickness; this thickened portion bears on its under side a deep massive cuneiform keel, which terminates upon the commencement of the entosternal piece. There is more or less thickening of this part in all the species of *Testudo*, and the amount of it is very variable in different individuals of the same species; but there is nothing approaching the same degree of contraction in reference to the thickness, nor aught like a developed keel, in any of the existing land-tortoises which we have either had an opportunity of examining, or seen described in systematic works on the tribe. The keel in the fossil is feebly shown in the young animal, but strongly marked in the adult. Conceiving that generic distinctions are only legitimate in the case of well-defined modifications affecting some of the leading characters in the organization of an animal, we do not consider ourselves warranted in attaching a higher systematic importance to the *Colossochelys* than as a subgenus of *Testudo*, which may technically be defined thus (the distinction resting mainly on the form of the sternum):—

Subgen. COLOSSOCHELYS.

Testa solida, immobilis, sterno antice in collum valde incrassatum, subtus carinâ crassâ cuneiformi instructum, angustato. —Testudo terrestris, staturâ et mole ingente (inde nomen *κολοσσός* et *χέλυς*) sui tribus prodigium! Olim in Indiæ Orientalis provinciis septentrionalibus degebat.

Colossochelys Atlas.

The first fossil remains of this colossal tortoise were dis-

covered by us in 1835 in the tertiary strata of the Sewalik hills; or Sub-Himalayahs skirting the southern foot of the great Himalayah chain. They were found associated with the remains of four extinct species of Mastodon and Elephant, species of Rhinoceros, Hippopotamus, Horse, Anoplotherium, Camel, Giraffe, Sivatherium, and a vast number of other Mammalia, including four or five species of Quadrumana. The Sewalik fauna included also a great number of reptilian forms, such as crocodiles and land and freshwater tortoises. Some of the crocodiles belong to extinct species, but others appear to be absolutely identical with species now living in the rivers of India: we allude in particular to the *Crocodilus longirostris* or Gharial (Gavial), from the existing forms of which we have been unable to detect any difference in heads dug out of the Sewalik hills. The same result applies to the existing *Emys tecta*, now a common species found in all parts of India. A very perfect fossil specimen, presenting the greater part of the evidence of the dermal scutes, is undistinguishable from the living forms, not varying more from these than they do among each other. Professor T. Bell, the highest living authority on the family, after a rigid examination, confirms the result at which we had arrived, that there are no characters shown by the fossil to justify its separation from the living *Emys tecta*. There are other cases which appear to yield similar results, but the evidence has not yet been sufficiently examined to justify a confident affirmation of the identity at present.

The remains of the *Colossochelys* were collected, during a period of eight or nine years, along a range of eighty miles of hilly country; they belong in consequence to a great number of different animals, varying in size and age. From the circumstances under which they are met with, in crushed fragments, contained in elevated strata which have undergone great disturbance, there is little room for hope that a perfect shell, or anything approaching a complete skeleton, will ever be found in the Sewalik hills. It is to be mentioned, however, that remains of many of the animals associated with the *Colossochelys* in the Sewalik hills have been discovered along the banks of the Irrawaddi in Ava, and in Perim Island in the Gulf of Cambay, showing that the same extinct fauna was formerly spread over the whole continent of India.

This is not the place to enter upon the geological question of the age of the Sewalik strata; suffice it to say, that the general bearing of the evidence is that they belong to the newer tertiary period. But another question arises: 'Are there any indications as to when this gigantic tortoise became extinct? or are there grounds for entertaining the

opinion that it may have descended to the human period?' Any *a priori* improbability, that an animal so hugely disproportionate to existing species should have lived down to be a contemporary with man, is destroyed by the fact that other species of Chelonians, which were coeval with the *Colossochelys* in the same fauna, have reached to the present time; and what is true in this respect of one species in a tribe may be equally true of every other placed under the same circumstances. We have as yet no direct evidence to the point from remains dug out of recent alluvial deposits, nor is there any historical testimony confirming it; but there are traditions connected with the cosmogonic speculations of almost all Eastern nations having reference to a tortoise of such gigantic size, as to be associated in their fabulous accounts with the elephant. Was this tortoise a mere creature of the imagination, or was the idea of it drawn from a reality, like the *Colossochelys*?

Without attempting to follow the tortoise tradition through all its ramifications, we may allude to the interesting fact of its existence even among the natives of America. The Iroquois Indians believe that there were originally, before the creation of the globe, six male beings in the air, but subject to mortality. There was no female among them to perpetuate their race; but learning that there was a being of this sort in heaven, one of them undertook the dangerous task of carrying her away. A bird (like the Garŭda of Vishnoo, or the Eagle of Jupiter) became the vehicle. He seduced the female by flattery and presents; she was turned out of heaven by the Supreme Deity, but was fortunately received upon the back of a tortoise, when the otter (an important agent in all the traditions of the American Indians) and the fishes disturbed the mud at the bottom of the ocean, and drawing it up round the tortoise formed a small island, which gradually became the earth. We may trace this tradition to an eastern source, from the circumstance that the female is said to have had two sons, one of whom slew the other; after which she had several children, from whom sprang the human race.

In this fable we have no comparative data as to the size of the tortoise, but in the Pythagorean cosmogony the infant world is represented as having been placed on the back of *an elephant, which was sustained on a huge tortoise.* It is in the Hindoo accounts, however, that we find the fable most circumstantially told, and especially in what relates to the second Avatar of Vishnoo, when the ocean was churned by means of the mountain Mundar placed on the back of the king of the tortoises, and the serpent Asokee used for the

churning rope. Vishnoo was made to assume the form of the tortoise and sustain the created world on his back to make it stable. So completely has this fable been impressed on the faith of the country, that the Hindoos to this day even believe that the world rests on the back of a tortoise. Sir William Jones gives the following as a translation from the great lyric poet Jyadeva: 'The earth stands firm on thy immensely broad back, which grows larger from the callus occasioned by bearing that vast burden. O Cesava! assuming the body of a tortoise, be victorious! Oh! Hurry, Lord of the Universe!'

The next occasion in Indian mythology where the tortoise figures prominently is in the narratives of the feats of the bird-demigod 'Garūda,' the carrier of Vishnoo. After stating the circumstances of his birth, and the disputes between his mother Vinūta and 'Kudroo,' the mother of the serpents, it is mentioned that he was sent on an expedition to bring 'Chundra' the moon, from whom the serpents were to derive the water of immortality. While pursuing his journey amidst strange adventures, Garūda met his father, Kŭshyŭpa, who directed him to 'appease his hunger' at a certain lake, where *an elephant and tortoise were fighting*. The body of the tortoise was 80 miles long—the elephant's 160. Garūda with one claw seized the elephant, with the other the tortoise, and perched with them on a tree 800 miles high.' He is then, after sundry adventures, stated to have fled to a mountain in an uninhabited country, and finished his repast on the tortoise and elephant.

In these three instances, taken from Pythagoras and the Hindoo mythology, we have reference to a gigantic form of tortoise, comparable in size with the elephant. Hence the question arises, are we to consider the idea as a mere fiction of the imagination, like the minotaur and the chimæra, the griffin, the dragon, and the cartazonon, &c., or as founded on some justifying reality? The Greek and Persian monsters are composed of fanciful and wild combinations of different portions of known animals into impossible forms, and, as Cuvier fitly remarks, they are merely the progeny of uncurbed imagination; but in the Indian cosmogonic forms we may trace an image of congruity through the maze of exaggeration with which they are invested. We have the elephant, then as at present, the largest of land animals, a fit supporter of the infant world; in the serpent Asokee, used at the churning of the ocean, we may trace a representative of the gigantic Indian python; and in the bird-god Garūda, with all his attributes, we may detect the gigantic crane of India (*Ciconia gigantea*) as supplying the origin. In like manner,

Fig. 1.

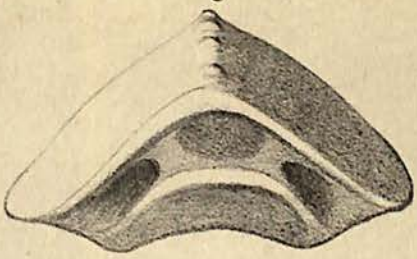


Fig. 2.

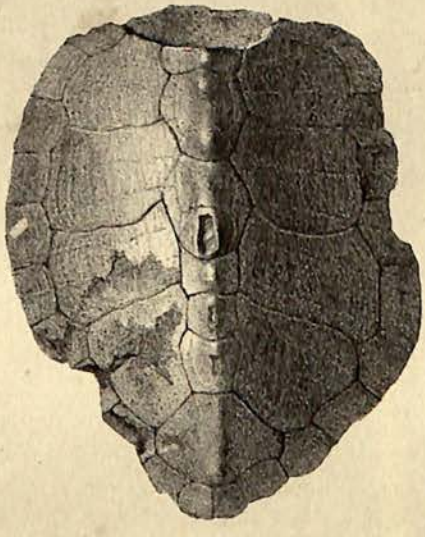


Fig. 3.

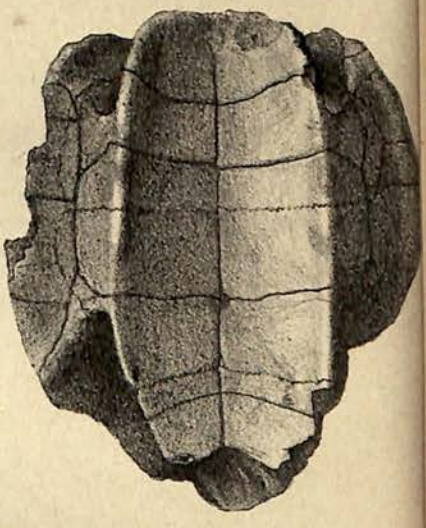


Fig. 6.

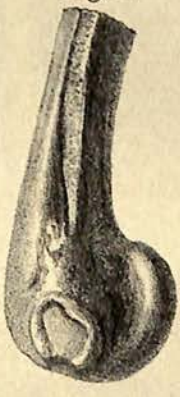


Fig. 4.

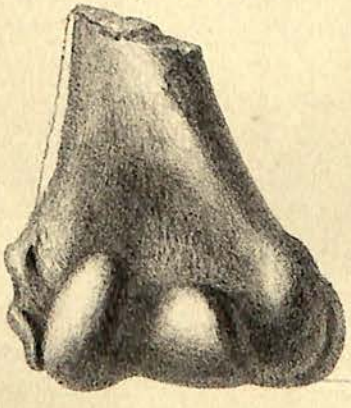


Fig. 5.

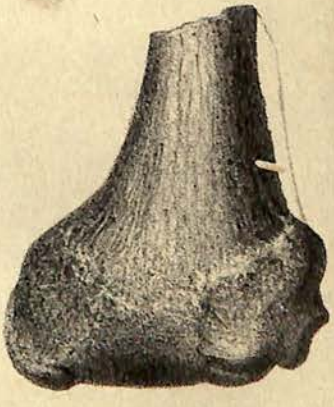
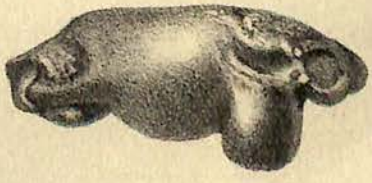


Fig. 7.



J. Dinkel del. et lith. W. West imp.

Figs. 1–3. Emys tecta. Figs. 4–7. Varanus Sivalensis.

the *Colossochelys* would supply a consistent representative of the tortoise that sustained the elephant and the world together. But if we are to suppose that the mythological notion of the tortoise was derived, as a symbol of strength, from some one of those small species which are now known to exist in India, this congruity of ideas, this harmony of representation would be at once violated; it would be as legitimate to talk of a rat or a mouse contending with an elephant, as of any known Indian tortoise to do the same in the case of the fable of Garūda. The fancy would scout the image as incongruous, and the weight even of mythology would not be strong enough to enforce it on the faith of the most superstitious epoch of the human race.

But the indications of mythological tradition are in every case vague and uncertain, and in the present instance we would not lay undue weight on the tendencies of such as concern the tortoise. We have entered so much at length on them on this occasion, from the important bearing which the point has on a very remarkable matter of early belief entertained by a large portion of the human race. The result at which we have arrived is, that there are fair grounds for entertaining the belief as probable that the *Colossochelys Atlas* may have lived down to an early period of the human epoch and become extinct since:—1st. From the fact that other Chelonian species and crocodiles, contemporaries of the *Colossochelys* in the Sewalik fauna, have survived. 2nd. From the indications of mythology in regard to a gigantic species of tortoise in India.

Some of the bones were analyzed with great care by Mr. Middleton, and yielded a large proportion of fluorine, the constituents being:—

Phosphate of lime	64·95
Carbonate of lime	22·36
Fluoride of calcium	11·68
Oxide of iron	1·00
A trace of chloride of sodium.	
	99·99

Other Sewalik fossil bones were at the same time subjected to analysis, such as the *Mastodon Elephantoïdes*, *Camelus Sivalensis*, Horse, Ruminants, &c., and the whole of them yielded similar results, with a proportion of fluoride of calcium varying from 9 to 11 per cent. This is much above the usual quantity found in fossil bones; the utmost that has been met with having been in bones of Anoplotherium from the Paris basin, viz. 14 per cent.

Manuscript Note by Dr. Falconer.[1]—FLUORINE.—There is

[1] Found among Dr. Falconer's papers.—[ED.]

another point of much interest connected with the mineral condition of these remains to which I am desirous of calling your attention. It may be in your recollection, sir, as well as that of other members of the Society now present, that on the first evening of the session, when our meeting opened so auspiciously, with Professor Owen's great paper on the Dinornis birds of New Zealand, it was suggested by myself, in regard to the doubtful antiquity of those remains, that some aid might be derived from chemical analysis, and ascertaining the presence to any extent, or the absence, of fluorine in the bones; as it had been determined by some of the most distinguished authorities in chemistry that fluorine frequently exists in very large quantity in fossil bones, as compared with recent ones; that its presence had even been ascertained in the bones of Pompeii and Herculaneum; and that it had been found in the greatest abundance in the most ancient remains. This suggestion was met with a very confident assertion by another speaker—a grave and worshipful signor, Mr. President—a pillar of the State, and the present head of a sister Society, that the opinions and the professed facts as to the existence of fluorine in fossils were mere delusions; the baseless fabrics of an air vision, and deserving to be consigned to the bottomless gulf of oblivion, along with transmutation and such like heresies. The general negation was founded on a single affirmed experiment by Sir H. Davy, who had failed to detect fluorine in some Kirkdale cave bones. It was satisfactory, under such circumstances, to find that one was connected in the so-called delusions with some of the greatest of modern chemists, such as Berzelius, Thénard, Vauquelin, &c.; and it has been entered on the record of science as an established fact. Fluorine has even been found to as great an extent as 14 per cent. in the fossil bones of Anoplotherium from the Paris basin. I was naturally desirous to ascertain how the case stood with the fossil bones from the N. of India, and in numerous analyses which have been made by my friend Mr. Middleton he has found it in every instance in abundance. Here is the evidence, on a piece of glass, in regard to its abundance in the fossil Tortoise. You know, sir, to what strange uses the gravest things may be turned. The philosophic Hamlet has traced the dust of Alexander the Great till he landed it as a plug to the bunghole of a beer barrel. In like manner, these tortoise remains, after many thousand years of repose, have been pounded in a mortar, stewed in a crucible, and so curiously dealt with as to be made to distil, as it were, their most hidden humours for the express purpose of engraving their own image on a plate of glass. The prevailing idea in the artist's mind, judging

from the design, appears to have been that the tortoises derived their fluorine from the vicious habit of smoking tobacco; but I beg to repudiate any connection with such an opinion.

The following is Mr. Middleton's Analysis of the Plastron of the Colossochelys Atlas[1] :—'Viewed through a magnifying lens, minute crystals, and here and there nests of minute crystals of carbonate of lime are seen to occupy the pores of the fossil associated with oxide of iron, which latter gives to it a slightly brownish tinge. It is readily soluble in nitric and hydrochloric acids. Five grains, finely powdered, were slowly raised to a red heat, and continued in that state for some time without having undergone from first to last any change of colour. It was found, on re-weighing, to have lost $\frac{1}{100}$ of a grain, a loss so small that it might easily have arisen from other causes than diminution in the weight of the substance. A piece, if exposed to the fumes evolved in the usual way, gave with remarkable readiness and decision indications of the presence of fluorine.

Judging from the quantity of fluorine present, I am disposed to assign to the existence of this animal a date much anterior to that of the *Mastodon Elephantoïdes*, as the bones of the former contain nearly twice as much fluorine as those of the latter. How far dissimilarity of structure in the tooth of the Mastodon (which I analyzed) and the plastron of the Tortoise may go to account for the disparity in the quantity of fluorine in them; how far, for instance, the latter be better suited for the absorption or development of fluorine than the former, I am not prepared to say; but as no reason suggests itself to me, other than that of the lapse of time, which abundant experiments have shown to be attended with the presence of that substance in bones, I do not think it necessary to withhold the conclusion at which I have arrived.

The analysis was performed by me in the laboratory of University College, with every possible care, and for greater certainty repeated. The following are the results :—

	Per cent.
Phosphate of lime	64·95
Carbonate of lime	22·36
Fluoride of calcium	11·68
Oxide of iron	1.00
A trace of chloride of sodium.	
	99·99

[1] Found among Dr. Falconer's papers.—[Ed.]

III.—Abstract of an Extempore Discourse on the Colossochelys Atlas, delivered before the British Association at York, on Saturday, September 28th, 1844, at 8 p.m., The Dean of Ely, President, in the Chair.[1]

This evening the Association, as on Friday, assembled in the Great Concert Hall of York to hear an extemporary discourse by Dr. Falconer, on the *Colossochelys Atlas* or Gigantic Fossil Tortoise, discovered along with numerous other extinct animals, by Captain Cautley and Dr. Falconer in the tertiary strata of the Sewalik hills, in the north of India. The temporary screen in front of the orchestra recess was sheeted over with a display of diagrams, maps, and sections, in illustration of the discourse, among which the most prominent was a very spirited and cleverly executed restoration drawing of the Sewalik colossus, done by Mr. Scharf, under the superintendence of Dr. Falconer, to the natural size, measuring, exclusive of curves, about 18½ feet. On stands beside the lecturer there was also a fine array of

[1] This abstract was written by Dr. Falconer himself, but was never published. The following notice, however, appeared in 'Chambers' Edinburgh Journal' for Nov. 23, 1844:—'Another evening was rendered still more agreeable by an account of certain recent discoveries in India. The demonstrator on this last occasion was Dr. Falconer, a young medical man recently returned from India on leave. The members, on entering this evening, were surprised by the picture of a tortoise, displayed on the green screen above the speaker's head, exhibiting an animal the same in form as ordinary land-tortoises, but about twelve feet long. Strange as it may seem, remains of this huge animal, to which the name of *Colossochelys Atlas* has been given, are found in the superficial gravel upon the Sewalik hills; some of these were shown, particularly one of the leg bones, the similarity of which to the corresponding bone of the modern diminutive species was easily recognized. It appears that this and a vast number of other animals, elsewhere found in the tertiary strata, are, in that part of the world discovered in the more recent gravels, showing that the tertiary species may have lived in certain districts down to a time nearer to our own era. And this idea Dr. Falconer connected in a very interesting manner with mythic traditions of India, descriptive of enormous tortoises, one of which was fabled to support the elephant by which the world was supported. It seemed not unlikely that these legends referred to animals which had been living in the early ages of mankind, but which have for many centuries been extinct. The plain and perspicuous, yet arresting address of Dr. Falconer, was universally allowed a high place among the scientific affairs of the week. He has made a most important contribution to geology; and the ample specimens which he has brought home enrich the museums to which they have been presented. His services are the more creditable to himself, that, placed in charge of the Botanic Garden upon the Sewalik hills, he had little means of cultivating the science in any of the more ordinary methods. When a canal excavation near the garden exposed to him a rich treasury of fossil bones, he had no means of studying in order to ascertain what those were; but he took an original method. He went off to the woods and wilderness and shot animals, from which he might study comparative anatomy, and by a reference to these he was able to refer the fossils to their proper species. What a crowning to years of toil, thus to be able at length to come before one of the most intelligent audiences in Europe, and enchain them with descriptions of such novelties in human knowledge!'

specimens of huge fragments derived from all parts of the skeleton of the *Colossochelys*.

Dr. Falconer commenced with a reference to the history of the reptilian forms discovered in the fossil state (chiefly in the older strata, such as the lias and oolite), among which colossal representatives have been found of almost all the known tribes, such as the Megalosaurus, Iguanodon, &c., besides numerous remarkable forms of which no analogues are now in existence, such as the Ichthyosaurus, Plesiosaurus, and Pterodactylus. Even the Batrachian order, or Frogs, was represented in the fossil state by the gigantic Labyrinthodon of Professor Owen. But no fossil *Testudinata*, remarkable either for size or deviation from existing forms, had hitherto been met with. The existing species of sea-turtle were larger than any which had been found of the order in the fossil state, and the most remarkably modified known form was an existing species, the *Chelys Matamata*. Nature, however, consistent in her course, had not left the Chelonian order without a grant. The *Colossochelys* fills up the apparent blank, and yet differs so little from the ordinary land-tortoise, in the general construction of its osseous frame, as hardly to constitute more than a sub-genus of *Testudo*, while at the same time it furnishes one of the most gigantic forms found in any section of the reptilian order.

The anatomical structure was then briefly described. The plastron or sternal portion of the shell affords the chief distinctive character, and the elements for determining the size, form, and affinities of the fossil. Dr. Falconer explained that the diagram was not drawn from any one entire specimen of the shell and skeleton, of which there was probably none in existence either above or below ground, but that it was what is called a Cuvierian restoration founded on the laws of relation between *special* and *general* structure; in fact a reconstruction of the form determined upon the collation of a vast number of specimens of the individual parts. Allusion was here made to the laws of reciprocal connection between special and general structure, which involves the necessary condition that every individual part has a definite relation to the aggregate form, and to every other part of it; or, to express the law in mathematical language, that each proportion of an animal is a function of every other proportion and of the sum of those proportions. The application of this law to the reconstruction of the *Colossochelys* was next considered, and it was shown how far the sternum, carapace, extremities, and head had common tendencies, and how far they warranted the size, form, and generic representation in the figure. The anatomy of the *Colosso-*

chelys was then described. The *episternal*, or anterior portion of the plastron, is 6½ inches thick, contracted into a diameter of 8 inches, bifid at the apex, and supplied on its inferior surface with a thick cuneiform keel. This keel constitutes one of the principal features in the fossil. The *entosternal* portion presents exactly the same character as in the ordinary forms of *Testudo*, the like being the case in regard to the *xiphosternal* or posterior pieces, of which there was a magnificent specimen exhibited on the table. The '*plastron*' or breast-plate in the adult animal was estimated to have been 9 feet 4 inches long. The '*carapace*' or buckler portion of the shell was described as coinciding in every leading character with the general form of the land-tortoises, of which in fact it exhibits but a hugely magnified representation. The same resemblance was found to hold good in regard to the dermal covering or scutes. The shell was estimated to have been about 12 feet 3 inches long measured along the chord, and 15 feet 9 inches measured along the curve of the back, 8 feet in transverse diameter, and about 6 feet high.

The extremities were then described, and shown to follow the same line of affinities as was indicated by the shell: viz., to be constructed precisely as in the land-tortoises, in which the form of the femur and humerus is marked by peculiar characters. These bones in the fossil are of a prodigious size, corresponding to the dimensions of the shell. A specimen comprising the upper part of the humerus was exhibited, exceeding in size the same portion of the corresponding bone of the Indian Rhinoceros, yet so like the humerus of an existing Tortoise that the outline of the fossil could pass for a magnified representation of the small recent bone, done by means of the pantograph. The same was found to hold good in regard to the construction of the feet, which are formed exactly on the plan of *Testudo*: viz., with columnar legs and truncated club-shaped hoofs, as in the proboscidean *Pachydermata*. The ungual phalanges or bones which support the nails were shown from specimens to equal the size of those of the largest Elephant.

Dr. Falconer then described the form of the head, which, like the rest of the skeleton, was closely allied to the ordinary forms of *Testudo*. The collection did not contain an adult specimen of the head, but from the proportions of a half-grown perfect specimen, the head was deduced to have been 2 feet long (see Plate XXXI.). The entire length of the *Colossochelys Atlas*, from the tip of the head to the extremity of the tail, was inferred to have been close upon 20 feet, and the animal was said to have stood upwards of 7 feet high.

DESCRIPTION OF PLATE XXXI.

COLOSSOCHELYS ATLAS.

The figures in this Plate have been drawn from the original specimens in the British Museum by Mr. Dinkel.

Fig. 1. Cranium of *Colossochelys Atlas*, one-half of the natural size. The Brit. Mus. number of the specimen is 39,819. (See pages 363 & 374.)

Fig. 2. Fragment of upper end of humerus, with globular articulating head of *Colossochelys Atlas*, one-fifth of the natural size. The specimen bears the number 16,913 in the British Museum Catalogue. (See pages 360, 364, 374, & 381.)

Fig. 3. Fragment of lower end of humerus of *Colos. Atlas*, numbered 39,825 in the Brit. Mus. Cat., and drawn about one-fifth of the natural size.

Figs. 4 and 5. Represent two different views of upper end of femur, with articulating head of *Colos. Atlas*, one-fifth of the natural size. The specimen is numbered 16,518 in the Brit. Mus. Cat. (See pages 363 & 374.)

Fig. 1.

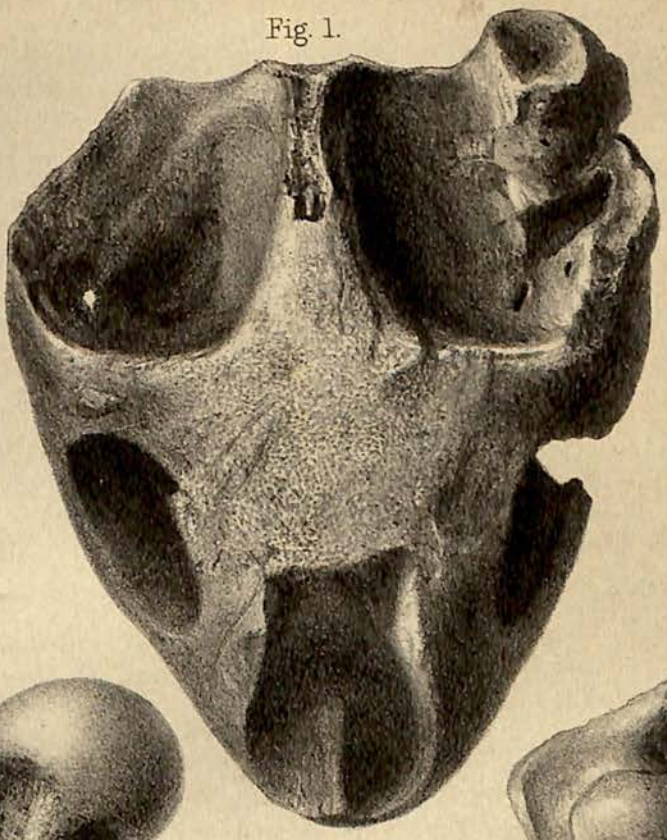


Fig. 2.

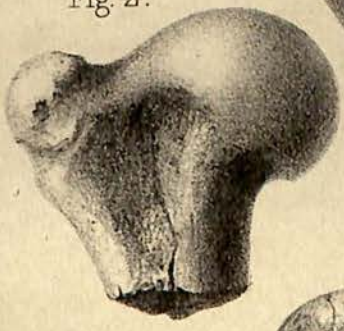


Fig. 3.

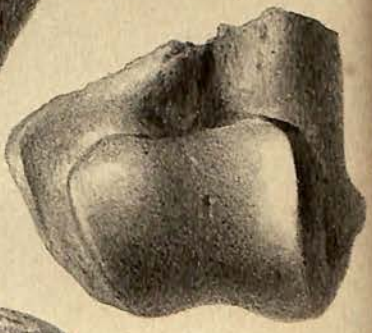


Fig. 4.

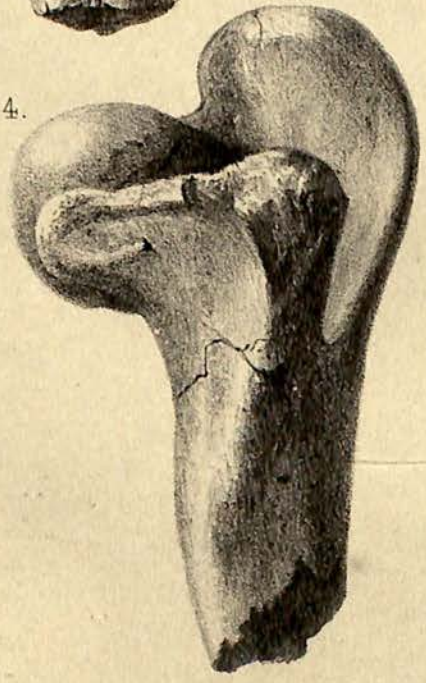
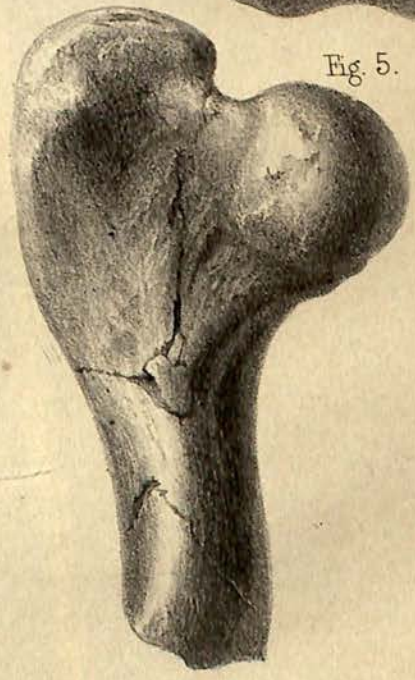


Fig. 5.



J. Dinkel del. et lith.

Colossochelys Atlas.

W. West imp

The whole of its organization proved that it was strictly a land animal, with herbivorous habits, and probably of the most inoffensive nature. The generic name given by Capt. Cautley and Dr. Falconer to the fossil has reference to its colossal size (*κολοσσός* et *χέλυς*), and the specific designation of *Atlas*, to its fitting representation of the mythological Tortoise that sustained the world in the systems of ancient cosmogony.

The principal part of the remains of the *Colossochelys* were collected during a period of eight or nine years along a range of about 100 miles of hilly country. They belong in consequence to a great number of different animals, varying in size and age. From the circumstances under which they are met with, in crushed fragments, contained in upheaved strata which have undergone considerable disturbance, there is no chance that an entire shell, or anything approaching a complete skeleton in a single specimen, will ever be disentombed from the Sewalik hills. When the first fragments, in huge amorphous masses, were found by the discoverers, they were utterly at a loss what to make of them, and for many months could do nothing more than look upon them in bewildered and nearly hopeless admiration. But no sooner was the clue found to the nature of a single specimen than every fragment moved into its place, so as to form a consistent whole.

Dr. Falconer then entered upon the question 'whether are there grounds for determining the period when the gigantic Tortoise became extinct, or are there any indications that it may have lived down to be contemporary with any portion of the human period?'

The *Moa* bird or *Dinornis* of New Zealand—a parallel instance of an equally gigantic form in another order—appears from very strong evidence only to have become very recently extinct, and any apparent *a priori* improbability that an animal so hugely disproportionate to existing species as the *Colossochelys* should have survived, so as to have been coexistent with man in the East, is removed by the fact that other species of Chelonians, which were coeval with the *Colossochelys* in the Sewalik fauna, have reached to the present time; and what is true in this respect, in regard to one species of the tribe, may be equally true of any or every other placed under the same circumstances. Some of the Crocodiles—in particular the *Crocodilus longirostris* or 'Gavial'—now existing in India, appear to be absolutely identical with forms dug out of the Sewalik hills. The same result was found to apply to the existing *Emys tecta*, now a common species in all parts of India. Dr. Falconer mentioned that there were other cases which appeared to yield similar results, but that the evidence had not been

sufficiently examined to justify a confident affirmation of identity at present. There is no direct evidence from history or from remains dug out of recent alluvial deposits that the *Colossochelys* has recently ceased to be a tenant of the globe; but there are traditions connected with the cosmogonic speculations of almost all Eastern nations having reference to a Tortoise of such gigantic size as to be associated in their fabulous accounts with the Elephant. Was this Tortoise merely a creature of the imagination, or was the idea of it drawn from a reality like the '*Colossochelys*?'

Besides a tradition current among the Iroquois Indians, in regard to the important share which the Tortoise had in the formation of the earth, there are several cases in ancient history bearing on the same point. In the Pythagorean cosmogony the infant world is represented as having been placed *on the back of an Elephant which was sustained on a huge Tortoise.* In the Hindoo accounts of the second Avator of Vishnoo the ocean is stated to have been churned by means of the mountain Mundar placed on the back of the King of the Tortoises, and the Serpent Asokee used as the churning-rope. Vishnoo was made to assume the form of the Tortoise, and sustain the created world on his back to make it stable. So completely has this fable been impressed on the faith of the country, that the Hindoos to this day even believe that the world rests on the back of a Tortoise. Again, the Tortoise figures prominently in the narratives of the feasts of the bird-demigod Garūda, who is represented on one occasion to have appeased his hunger at a certain lake *where an Elephant and a Tortoise were fighting.* The dimensions are given in the extravagant style of cosmogony.

In these three instances there is distinct reference to a gigantic form of Tortoise comparable in size with the Elephant. Hence arises the question, are we to regard the idea as a mere fiction of the imagination, like the Minotaur, the Chimæra, the Griffin, Dragon, and Cartazonon, &c., or as founded on some justifying reality. The Greek and Persian monsters are composed of wild and fanciful combinations of different portions of known animals into impossible forms, and are merely the progeny of uncurbed imagination. But in the Indian cosmogonic forms there is an image of congruity which may be traced through the maze of exaggeration with which they are invested. We have the Elephant then, as at present, the largest of land animals, a fit supporter of the infant world; and the *Colossochelys* would supply a consistent representative of the Tortoise which sustained the Elephant and the world together. But if we are to suppose that the mythological idea of the Tortoise was derived as a symbol of strength,

from some one of those small species which are now known to exist in India, this harmony of representation would be at once violated; it would be as legitimate to talk of a rat or a mouse contending with an elephant as of any known tortoise to do the like in the case of the fable of Garūda. Imagination would scout the image as incongruous, and the weight even of mythology would not be strong enough to enforce it on the belief of the most superstitious period of the human race. Dr. Falconer stated that he would not lay undue stress on the tendencies of mythological tradition, which are generally so vague and uncertain; but that he had entered so fully on the point from the important connection which it had with a very remarkable matter of belief entertained by a large portion of mankind.

Dr. Falconer then described the animals associated with the *Colossochelys* in the Sewalik fauna, including no less than five extinct species of Mastodon and Elephant peculiar to India, viz., the *Mastodon latidens* (Clift), *M. Elephantoïdes*[1] (Clift), *M. Sivalensis* (Falc. & Caut.), *Elephas planifrons* (F. & C.), *E. Hysudricus* (F. & C.).

[1] Subsequently subdivided by Dr. Falconer into *Elephas Cliftii*, and *Elephas insignis*.—[Ed.]

Fig. 13.

THE ELEPHANT VICTORIOUS OVER THE TORTOISE, SUPPORTING THE WORLD, AND UNFOLDING THE MYSTERIES OF THE FAUNA SIVALENSIS. FROM A SKETCH IN PENCIL IN ONE OF DR. FALCONER'S NOTE-BOOKS BY THE LATE PROF. EDWARD FORBES.

IV. — Anatomical Description of the Colossochelys Atlas, being MS. Notes for the Lecture delivered at the British Association in September 1844.

The Sternum.—In the Chelonians the sternum is a highly developed apparatus, and consists in all the species invariably of 9 pieces, 8 of which are pairs and 1 an odd piece; 2 episternals, 2 hyosternals, 2 hyposternals, 2 xiphosternals, and 1 entosternal. In the Chelonia and Trionyx the pieces are detached; in the Land-Tortoises and *Emydæ* they are solid. The fragments of the *Colossochelys* show that the episternals were of an amorphous thick form, cleft at the apex, with a deep cuneiform keel underneath. The entosternal shows an exact correspondence in form and in every particular with several *Testudines*. In the specimen in the Zoological Society the length of sternum is 32 inches, and the length of epi- and ento-sternal pieces 10 inches. In *Colossochelys*, the epi- and ento-sternal pieces measure 35 inches, and the inferred length, on the same proportions, of the entire plastron is 9 feet 4 inches. The lateral curved expansions are also to be noted. All these concurrent marks are found in no other Chelonians than the *Testudines*. Hence the first indication of its being a Tortoise is exhibited by the sternum.

The xiphosternals are cleft behind under the tail. In the fossil, in thickening, marginal ridge, and general characters they resemble the living Tortoise. In the hyposternals there is a similar correspondence and thickening. The whole of the sternum indicates a testudinate animal of enormous size, and a true Land-Tortoise.

Character of the Carapace.—The dorsal shield consists of 10 pairs of ribs in 8 sutured pieces (the 1st and 10th being confluent with the 2nd and 8th), connected with as many vertebral plates; there are 11 vertebral plates in all (the last or supra-caudal having no attachment to the ribs), and 11 marginal or sterno-costal pieces corresponding to the cartilages of the ribs. There are 10 dorsal vertebræ, the first free and homomorphous with the cervical vertebræ, of which there are 7 (apparently 8).

The carapace of the Land Tortoises is short, very elevated and arched, and more or less vertical at the sides, as compared with other Chelonians. The thickness of bone in the convexity is almost in an inverse ratio to the size. The physiological reason of this is that the smaller the animal the more liable it is to injury, and it requires a greater arch to sustain it. There are no complete pieces in the fossil remains, and the reasons of this are the curvature and thinness. The most marked pieces in the carapace are the sterno-costal,

of which a large fragment is attached to the ribs, and gives the form of the inguinal sinus for the emission of the leg, exactly as in the *Testudo Indica*. The engroined apices indicate the age to be young, and afford an excellent element of measurement, as the sterno-costal pieces bear a direct ratio to the development of the ribs to which they are attached. Another crucial proof of the size is derived from a comparison of corresponding measurements in *Colossochelys* and *Testudo Indica*. (See *antea*, pp. 364 and 374.)

The correspondence shown in the symphysized portion of the sterno-costal pieces is borne out by other pieces all round the rim, viz., the great curvature anteriorly, and the abrupt reflexion as in the Land Tortoises, and also the great thickening of the rim, and the furrows of the epidermal scutes. The concave or spoon-shaped form of the supra-caudal plate is also exactly alike.

The rib pieces are less common among the remains discovered. They show a total disappearance of sutures. One large piece, comprising the second vertebral plate and several vertebræ of the back, with the keel, indicate that the back was flattened out and had little convexity. Other pieces indicate the same character in the sacral vertebræ. In short, the whole gives the form of a gigantic Tortoise, with a flattened back, compressed sides, vertical in front, with an abrupt marginal reflexion.

There is a peculiarity in the bodies of the vertebræ being detached, requiring to be artificially held together in the recent skeleton. None are available for description, but the vertebral pieces to which they are attached, the sacral ones, are among the specimens. This is also indicated in the keel.

As to the relation in size of the plastron to the carapace in the smaller species, for safety the plastron is elongated so as to close up the openings before and behind; this goes on increasing nearly in the ratio of the reflexion of the limb. Taking the *Testudo Indica* as the standard, we find the plastron to the carapace being nearly in the ratio of 3 to 4, according to which the carapace of *Colossochelys* would be 12 feet 6 inches long, and the curvature 15·9 inches, the size intended to be given in the figure.

We shall now see how the vertebræ agree. The bones of the skeleton of the *Testudinata*, viewed as a whole, undergo more singular modifications than we observe in any other of the higher reptilia, and more than is observed throughout the whole order of birds or mammalia. The number of vertebræ, excepting of the tail, is pretty constant in all; and the principal modification is observed in those that are

attached to the buckler. In Turtles, the soft Tortoises, and the Terrapins, the bodies of the dorsal vertebræ are connected with the vertebral plates by a bony lamella on either side forming a continuous osseous canal upon the upper surfaces of the bodies in which the spinal marrow is lodged. The bodies of the vertebræ are consequently attached with considerable strength to the buckler, and do not separate readily when the soft parts decompose. But in the Land Tortoises the only connection between the vertebral plates and the shafts of the bodies is established by means of a membranous lamella, there being no osseous canal for the spinal marrow, which is lodged in a cavity formed by a duplicature of this membranous lamella and a groove on the upper surface of the bodies. The only osseous connection is established by means of a thin slender splint-shaped process, given off on either side from the vertebral plates to the common point of union between the bodies of two vertebræ. The bodies are consequently but feebly attached, their principal strength arising from their being arranged in an arch, and they generally fall off when the soft parts decompose. The line of attachment of the membrane is indicated by a ridge along the axis of the plates. In all the vertebral fragments of the fossil we observe precisely the same arrangement; there is a well-marked keeled ridge along the axis, indicating the line of attachment of the membrane, and no indication of any bony canal—nothing besides the thin splint-shaped processes, or new apophyses, indicating, as in the rest of the skeleton, the strictly *Testudo* affinities of the fossil.

The same leading resemblances are found in the sacral vertebræ, which show the surfaces for the attachment of the posterior and upper angles of the ilium exactly as in *Testudo*.

While on the vertebræ of the trunk, I may mention that there are no caudal vertebræ in the collection, and that, as the number of these vary in the Chelonians from 18 to 26, the restoration in the drawing has been assumed from the type of the Land Tortoises, in which the tail is thick and the higher number prevails. In certain species of this genus whose habits have been well observed, the tail has been noticed to be used as a pivot or fifth leg to sustain them, especially during the act of defæcation; and, from the huge size of the fossil, and the weight which its limbs had to sustain, it is at least highly probable that nature gifted it with a similar aid in its tail, although we have no direct evidence on the point.

We shall now pass to the special organs of progression, and see how the extremities of the fossil were constructed. In regard to the anterior member, no remains have yet been

detected in the collection of the scapular arch, although they will in all probability be found yet to give direct evidence as to its build.

The humerus was of large size, its estimated length being 28 to 30 inches; but it corresponded exactly with that of the existing Tortoise in its singular curve, globular head, large size of inner tuberosity, and foramen for the brachial nerve at lower end. The concentric arrangement of the corpuscles of Retzius round the Haversian canals seen in the ungual bones of the toes is a certain mark of a reptilian.

V.—Description by Dr. Falconer of Fossil Remains of Colossochelys and Testudo in the Museum of the Asiatic Society of Bengal.

[The catalogue contains numerous references to remains of the *Colossochelys*:—from Ava, Nos. 196, 241; from the Sewalik hills, Nos. 654 to 674, and Nos. 860 to 863; and from Perim Island, Nos. 98 and 112. The chief of these is the following, supposed to be from the Sewalik hills.—Ed.]:—

No. 654. *Colossochelys Atlas.*—Fine fragment, comprising the anterior portion of the thickened episternum (of the plastron); it is bifid at the apex, behind which it is contracted and supplied underneath with a thick cuneiform keel. No portion of the thin part of the bone near the entosternum is present; the specimen is tinged black, highly infiltrated with iron, and crusted over with a thin coat of gritty sandstone like some of the Ava specimens; but it bears no mark. The tip of the left bifurcation is broken off; the right is entire.

	Inches
Length of fragment	16·
Ditto of thick portion of episternum, to tip of bifurcation . .	13·
Width of thickened part behind bifurcation	6·5
Greatest thickness	5·1

Col. Colvin is stated (Journ. A. S., v. p. 184) to have presented to the Society some huge fragment of this gigantic Tortoise, but the specimen in mineral condition is unlike the generality of the Sewalik fossils. It may be from Ava (Col. Burney), as Dr. F. found numerous fragments of the gigantic Tortoise among the specimens presented to the Geolog. Soc. by Mr. Crawfurd. This episternum is not of a full-sized animal, Dr. F. having met with it 6½ in. thick with a diam. of 8 in. at the contracted part.

[The description of a specimen of fossil *Testudo* in the same collection, also from the Sewalik hills, is also worth quoting.—Ed.]

No. 675. *Testudo.*—Left side of plastron comprising the episternal, entosternal, and mesosternal, separated along the median suture. Episternum thick and overarching the entosternal, in form and markings very much like *Testudo stellata*. This was a small Land-Tortoise, having no connection with the *Colossochelys*, and probably a young animal, judging from the openness of the sutures.

XXI. ON A FOSSIL SPECIES OF EMYS FROM THE SEWALIK HILLS, REFERABLE TO THE EXISTING EMYS TECTA (BELL).[1]

THE almost constant distinctness of species between forms observed in the true fossil state and recent ones, in the mammalia and reptilia, requires that every apparent exceptional case should be rigidly examined, and have the strongest evidence to sustain it. The land and fresh-water Tortoises, when well preserved in the fossil state, supply the required character, for determining a case of this kind, under much more favourable circumstances, and in greater abundance, than any other tribe of the reptilia or the mammalia. For, with the latter, the evidence is almost invariably limited to the bony skeleton: while, in the Tortoises we have, in addition, the characters presented by the dermal integument or horny scutes which leave well-marked impressions indicating their form and extent, these scutes furnishing to naturalists the best marks for the distinction of species in the living state.

The small Indian species of Emys, well known under the name of *E. tecta*,[2] is readily distinguished from every other in the genus by the peculiar form of its carapace, which, instead of being vaulted, as is usual in the tribe, slopes down on either side from the ridge of the back, with a pitch nearly equal to a right angle, resembling somewhat the roof of a house. In addition, the three anterior vertebral scutes are elevated each into an obtuse point of which the posterior one is the most prominent, so as to form an uninterrupted tri-tubercular keel. The plastron is slightly curved lengthwise with a well-marked keel at either side, and throws off its alæ inclined at a considerable angle upwards. The *E. Bellii* is the only other species that has anything of a 'tectiform' carapace—but in a much slighter degree—and it is further

[1] This essay was written in 1844, but is now for the first time published. The specimen described in it is now in the British Museum, and from it the drawings in Plate xxxii. have been made by Mr. Dinkel. Among the Sewalik specimens in the British Museum there are likewise specimens of other species of *Emys* as well as of *Trionyx* and *Testudo*.—[ED.]

[2] *Emys tectum* in MS.—[ED.]

readily distinguished by a more depressed form, and the absence of the three vertebral prominences.

Plate XXXII. represents the shell of a fossil Emys from the tertiary strata of the Sewalik hills. The specimen has all the mineral characters of an ancient fossil. It was embedded in a hard sandstone matrix which fills the hollow of the shell, and the bony part is densely infiltrated with hydrate of iron and siliceous matter, so as to give it a dark colour and great specific gravity. It comprises nearly the whole of the carapace as far back as the commencement of the last vertebral scute. The margin is broken off in front, and the gular and anal portions of the plastron are also wanting. All the rest of the shell is distinctly shown. It had been exposed to a crush which has altered a little the form of the shell at the junction of the right sterno-costal pieces with the ribs, and caused a longitudinal 'fault' on the left side of the plastron between the median line and the keel.

The fossil agrees so closely with *Emys tecta* in size and general form that the resemblance is observed to be very striking at the first glance. It has the same high-pitched, roof-shaped carapace, the same tri-tubercular keel occupying the first three vertebral scutes, and a similarly formed plastron. A like agreement runs throughout the other details of the characters.

The carapace of the *E. tecta* is comparatively high for its size, the transverse diameter being about two-thirds of the length, and the height in the same proportion to the diameter. The profile from back to front along the vertebral ridge is a very depressed ellipse segment, and the horizontal outline is oval with greater width at the inguinal than at the humeral region. In all these particulars the fossil, in so far as it has the character to show, agrees closely with the recent form. It is not so high in proportion to its width as the smaller sized specimens of *E. tecta*, but in the latter the shell is observed to become more depressed with the increase of size and age, the fossil being in an intermediate condition between the young and the old form. The nuchal scute in *Emys tecta* is always small, but subject to great difference in size, in different individuals. In some specimens, and often the largest, it is a minute rectilineal lobule, while in others it expands behind into two angular wings, the difference being probably sexual. It is not shown in the fossil. The first vertebral scute is also subject to a considerable range of difference in form. It is an irregular quadrangular pentagon, wider in front than behind, the convergence varying greatly in amount in different individuals. In the fossil the exact form is not distinctly seen, though it seems to converge

less, and to be squarer, than generally holds in the recent forms; but probably it does not differ in a greater degree than the extremes of these do from each other. The second and third vertebral scutes are hexagonal, both in the recent *Emys tecta* and in the fossil. Both agree alike in the relative proportion of the ridge borne by each of these scutes, which is most protuberant in the third or central one of the series. The outline of the fourth scute is not distinguishable in the fossil, and the fifth one is wanting; but it is obvious that these two scutes were more elongated than the anterior ones, a point which constitutes one of the distinctive characters of the recent species, in which the two last vertebral scutes are as long as the three first. In this there is another close agreement between the fossil and the existing form.

The outline of the costal scutes is obscured in the fossil, and not satisfactorily distinguishable from the sutures, so that a minute comparison with the corresponding parts of the recent form is not in this instance practicable.

The margino-collar scutes vary a good deal between triangular and pentagonal in the existing *Emys tecta*, the latter form prevailing in those which have the broadest nuchal scute. The fossil has the margino-collar pentagonal, and with the same arrangement of the sides as in a recent form. A like correspondence runs through the margino-humeral and margino-lateral scutes, which are oblong, rectangular, or square both in the *Emys tecta* and in the fossil. The agreement is close, down to minute particulars in the size of the angle of junction between the first margino-lateral scute and the humeral scute of the plastron. The same holds with the form and extent of the axillary and inguinal scutes, which differ greatly in nearly allied species. The minute axillary foramen has exactly the same position, relatively to the second margino-humeral and axillary scutes, in the fossil as in the recent specimen.

The crushing force to which the fossil has been subjected has caused a longitudinal fracture and 'fault' along the left side of the plastron, and a depression along its median line. Its anterior and posterior extremities are wanting. There is no direct evidence, therefore, in regard to the proportion of length to breadth, but the impressions of the sternal scutes are fortunately well preserved, so as to admit of minute comparison with those of the *Emys tecta*. The plastron in the latter has a strongly marked keel on either side, along the line of margin, and the alæ are given off at a considerable angle upwards, to unite with the sterno-costal pieces, so that the rim of the carapace is raised high above the level of the sternum. In both particulars, and in the relatively less

DESCRIPTION OF PLATE XXXII.

EMYS TECTA AND VARANUS SIVALENSIS.

Figs. 1 and 2. Represent the upper and under surfaces of the shell of *Emys tecta*, a species of Tortoise still existing in India, but also found fossil in the Sewalik Hills. The specimen appears to be the identical one described in Dr. Falconer's memoir (page 382). It has been drawn by Mr. Dinkel from the original in the British Museum (Cat. No. 39,837), one-third of the natural size. Another fossil specimen, apparently of the same species, is numbered 17,435 in the Brit. Mus. Cat.

Fig. 3. Is a diagrammatic view of the same specimen, endwise, to show the roofed shape of the shell.

Figs. 4, 5, 6, and 7. Lower end of humerus, with articulating surface, of *Varanus Sivalensis*, or fossil Monitor of the Sewalik Hills, two-thirds of the natural size. This specimen appears to be unique. The specimen itself, with drawings, was found thus designated in Dr. Falconer's handwriting in his private collection, and has been deposited in the Palæontological Gallery of the British Museum.

amount of alar to marginal surface, there is the closest agreement between the fossil and the recent forms. The pectoral scutes in the recent form are rectangular and oblong transversely, and the abdominal scutes nearly square; the anterior edge of each makes a sweep forwards as it rises over the lateral keel, and then bends back to join on with the corresponding marginal scute at an angle. In all these there is a very close agreement between the plastron of the fossil and of the recent form.

The last point to be noticed concerns the interior of the shell. In the Land Tortoises and the genera allied to Emys the hyposternal pieces of the plastron give off, on either side, an apophysis which ascends on the inside of the third sterno-costal piece as far as the first rib, and acts as a brace or buttress to strengthen the arch of the dorsal buckler. In like manner the hyposternal pieces send off a similar apophysis on either side, which ascends along the inside of the seventh sterno-costal piece up to the sixth rib, strengthening the carapace behind. In the small *Emys tecta* these apophyses are greatly developed and expanded into wide plates, like incomplete diaphragmata, which project into the cavity of the shell, and contract the front and back apertures. The anterior apophyses ascend nearly as high as the head of the first rib, converging like the spandrels of a gothic arch. These plate apophyses are constructed in the fossil on exactly the same plan as in the recent species.

In short, after a rigid comparison conducted through all the details of size, form, relative proportion, and the dermal characters, there is the closest agreement between the fossil and the recent *Emys tecta*. The only discernible difference is a slight one of form, in the anterior vertebral scutes, which are known to be very variable in different individuals of the existing species, and the fossil does not appear to differ more from these than individuals among them do from one another. Hence arises the question, are we entitled to regard the fossil Emys as belonging to the same species with the *Emys tecta*? The point is one of much importance, both as it affects the established principles in Natural History regarding the ideas comprehended under the name of species and, in the present instance specially, from the fossils with which the specimen was found associated.

The received opinion in regard to the meaning of species is, that all forms are to be considered of one and the same species, which derive their origin from one and the same kind of ancestors, or which do not differ more from these than they do among themselves. Tried by this test, the fossil as above described is clearly referable to the *Emys*

tecta. But a great authority, one of the most profound naturalists of the age, M. Agassiz, after running over a vast field of observations, has arrived at a very different conception of the meaning of 'Species.' He states his opinion to be, 'that no so-termed character, that is, no observable mark can be so striking as to indicate an absolute specific distinction; but at the same time it should never be regarded as so trifling as to point to absolute identity; that characters do not mark off species, but that the combined relations to the external world in all circumstances do.' He believes that he can show 'that many organic beings are specifically distinct, or at least that they stand in no genealogical relations to one another, although the individuals are so like as to be confounded.' He further advances the opinion 'that no species occurs in two geological formations—nay, not even in two different parts of one formation;' and he believes 'that hereafter it will become necessary to express the specific difference of organic remains by the circumstances of their occurrence without its *being possible* to assign distinctions to them.'

If we are to apply this conception of 'Species' to the fossil it must at once be considered as distinct from *Emys tecta*, for it comes from a different geological formation, where it is associated with numerous extinct forms. But it is obvious that this part of the statement is nothing more than a begging of the question. The distinctness of the species must first be proved, in every case, on independent grounds before the asserted law regarding the order of their occurrence can be admitted. And, in regard to the other statement, that organic forms may be so like as to be undistinguishable and yet be specifically distinct, and that no external characters can be so marked as to determine specific difference, they seem to imply little short of a sort of Natural History negation of the universal axiom 'that things which are equal to the same are equal to one another.' M. Agassiz appears to entertain the received opinion among naturalists that common genealogy constitutes the essence of a species, but the quoted expressions would imply that he abandons external characters as the test by which such genealogy is to be judged of.

But naturalists have no right, in determining the specific nature of an organic form, to take into any account the geological position whence it came, any more than geographical place in regard to existing forms. The species ought to be ascertained from the observable marks which it presents apart from every extraneous consideration; the proper order of succession being to apply the result thus arrived at to

geology and geography, and not to determine the species in any degree from either. Anything short of this is but tampering with the right evidence.

Unless we are to continue to take modifications of form and constant external characters as sufficient tests of common origin or like descent, there is an end to the power of discriminating species, and the foundations of the science are undermined. But the majority of naturalists are agreed that with existing forms the evidence is sufficient, and no adequate reasons have yet been brought forward to show why the same should not be believed to hold in the case of extinct forms. In fact, a firm belief in it is the bases on which all our investigations are conducted.

Under this view, conceiving that we are not justified in constituting a difference where we do not find it, we infer that the fossil Emys is specifically identical with the existing *Emys tecta*, for it agrees as closely with the forms grouped under that name as these do with one another.

The *Emys tecta*, according to our present state of knowledge, is confined to India, where it is found in great abundance in the Ganges and in ponds in the North-western Provinces, and in Bengal.

The fossil came from the tertiary strata of the Sewalik hills, where it was associated with the remains of *Colossochelys*, *Trionyx*, and other Chelonians; and of Mastodon, Hippopotamus, Sivatherium, Camel, &c. The precise locality is not known.

If the view taken of its identity with *Emys tecta* prove correct, the fossil will furnish a good instance of the permanence, and, within certain limits, invariableness, of species during a long course of time extending through more than one geological epoch. Such instances are so abundant among the Mollusca, as to have constituted the basis of Mr. Lyell's classification of the tertiary strata. But they are so extremely rare among the Vertebrata, that there is perhaps hardly a single well authenticated case on record. Agassiz goes the length of stating that he has found his conclusion regarding the absence of a species from two geological formations, and even from two different paths of one formation, to have been '*invariably confirmed* by fossil fishes and *Echinodermata*.'

APPENDIX TO MEMOIR ON EMYS.

Manuscript Memorandum by Dr. Falconer, April 1844.

Mr. T. Bell's Opinion of the fossil 'Emys tecta.'—'On comparing the fossil with two specimens of recent *Emys tecta*, it looks a little flatter, but in this respect it does not differ more from either than these do between themselves, and certainly not more than would lead me to think, were it a recent one, that it was the same species. In regard to the first vertebral plaque, it is broader, flatter, and squarer; but this is liable to variation in the recent species to an equal extent. If the three specimens were all recent, I would merely consider them as varieties of the same species.'

'This,' adds Dr. F., 'is an admirable fact; for if this species has lived down to the human period, why might not the *Colossochelys* have done so? Refer to Ward's "History of the Hindoos," to the article "Garuda or Gŭroorā," the king of the birds, for the fable of his having found an elephant and a tortoise *contending together*, and having made a repast upon them. Joining the indication given by the Hindoo mythology with the determined fact of the little *Emys tecta* having survived from the fossil period down to the present day, I have put forward the opinion that the big Tortoise may have survived also, and only become extinct within the human period. *This is a most important matter in reference to the history of man.*' (Letter to Captain Cautley, April 1844.)

XXII. NOTE ON THE FRESHWATER SHELLS FROM THE SEWALIK HILLS.

BY THE LATE PROFESSOR EDWARD FORBES.[1]

RECENT.	FOSSIL.
Pulmonifera:	
Planorbis 1 (identical with specimen unnamed in Mr. Lyell's collection).	Planorbis identical with No. 1.
„ 2 (in Mr. Lyell's collection unnamed).	
„ 3	
„ 4	
	Pupa? Not resembling any specimens I have seen in the East.
Pectenibranchiata:	
Paludina unicolor	Paludina unicolor
„ Bengalensis	allied to P. Bengalensis, but apparently distinct.
„ (in Mr. Lyell's collection unnamed)	
Melania thiarella	Melania, quite distinct from any recent one I have seen.
„ corrugata	
Ampullaria glauca?	Ampullaria glauca
	identical with specimens from the Jumna. Differing somewhat from the recent Sewalik specimens.
Lamellibranchiata:	
Unio favidens, Benson (Mr. Lyell's specimen; U. corrugata, Lam. ?)	Unio favidens, a variety.
„ marginalis, Lam.	„ (near a Jumna specimen in Mr. Lyell's collection).
„ (undescribed ?)	„
„ (undescribed ?)	„
	„
	„
	„
	„
	„
Cyrena (small species).	„

[1] N.B. The materials for this comparison in recent forms of India are very limited and incomplete.—[H. F.]

This note, by Professor Forbes, was written about 1846. It has not been published before. Several of the Sewalik fossil freshwater shells were figured in the Journal of the Asiatic Society, vol. iv. Plate xlviii.—[ED].

Remarks on the List.

The total number of fossil species belonging to freshwater genera is 15.

The total number of recent species brought from the same country is 15.

Four of the fossils are identical with recent species.

The remainder are probably extinct forms. They consist of:—

1st. A *Paludina*, which, though extremely near *P. Bengalensis*, must be regarded rather as its representative than its homologue.

2nd. A *Melania* which is very distinct from any Indian form I can find a record of, and which appears to have taken the place of the existing *Melania thiarella*. I have seen 10 Indian *Melaniæ*; it is none of them.

3rd. Of a series of *Uniones* which are different from any species of which I can find a record. In 1838 Mr. Lea enumerated 13 species as the total number of known Asiatic *Uniones*. Of the 10 Sewalik fossil species, 1 only is identical with any of these 13 species, so that 9 remain to be accounted for. The common *Unio* of India appears to be *U. marginalis* of Lamarck, which is not to be found among these fossils.

Of the species found fossil which are identical with recent forms, the only *Unio* appears to be identical with one of the commonest existing species of India. The *Paludina* is the *P. unicolor* which is found among the shells of the Paris basin, and also in the mammilliferous crag of England. At present this species ranges from Egypt to India. The *Ampullaria* is remarkable for bearing a more close resemblance to the individuals of the species from the Jumna than to those existing at present in the Sewalik district.

Besides these fossil freshwater shells there is a species of *Pupa* or *Bulimus* with which I am unacquainted.

On the whole I am inclined to regard the evidence of the Sewalik Molluscan fauna as indicative of the older Pliocene period—*at latest.*

E. Forbes.

XXIII. DESCRIPTION OF SOME FOSSIL REMAINS OF DINOTHERIUM, GIRAFFE, AND OTHER MAMMALIA, FROM PERIM ISLAND, GULF OF CAMBAY, WESTERN COAST OF INDIA.[1]

(Chiefly from the Collection presented by Captain Fulljames, of the Bombay Engineers, to the Museum of the Geological Society.)

BY H. FALCONER, M.D.

DURING the late meeting of the British Association, at Cambridge, I made a communication[2] to the Geological section on some new additions to the Fossil Fauna of India, from Perim Island, in the Gulf of Cambay. Among these were mentioned a species of *Dinotherium* and of *Giraffe*, and a new Ruminant genus of a size nearly equalling the *Sivatherium*, found associated with remains of *Mastodon*, *Elephant*, *Rhinoceros*, *Hippopotamus*, and several species of Ruminants. The occurrence of *Dinotherium* in the extinct fauna of India is a point of such interest that no delay ought to take place in laying before palæontologists the evidence upon which

[1] *Note by the President.*—The following letter with reference to the subject of this Memoir has been received from Dr. Falconer:—

To the President of the Geological Society.

SIR,—Having had occasion to examine the Indian fossils in the Museum of the Geological Society with reference to the work on which I am at present engaged on the extinct Fauna of Northern India, and having found in the collection of fossil bones from Perim Island, presented to the Society in 1840 by Captain Fulljames, several remains of the highest interest which have not yet been described, I have in compliance with your desire made a brief description of them, which I have now the satisfaction of forwarding.

I have the honour to be, Sir,
Your most obedient Servant,
H. FALCONER.

London : July 1845.

The collection of fossil bones presented to the Geological Society by Captain Fulljames not having been accompanied by any memoir, and no description of it having yet been given in the publications of the Society, the President and Council have not hesitated to deviate from their usual course with regard to the publication of memoirs, and have directed the insertion of Dr. Falconer's communication in the present number of the Journal of the Society.

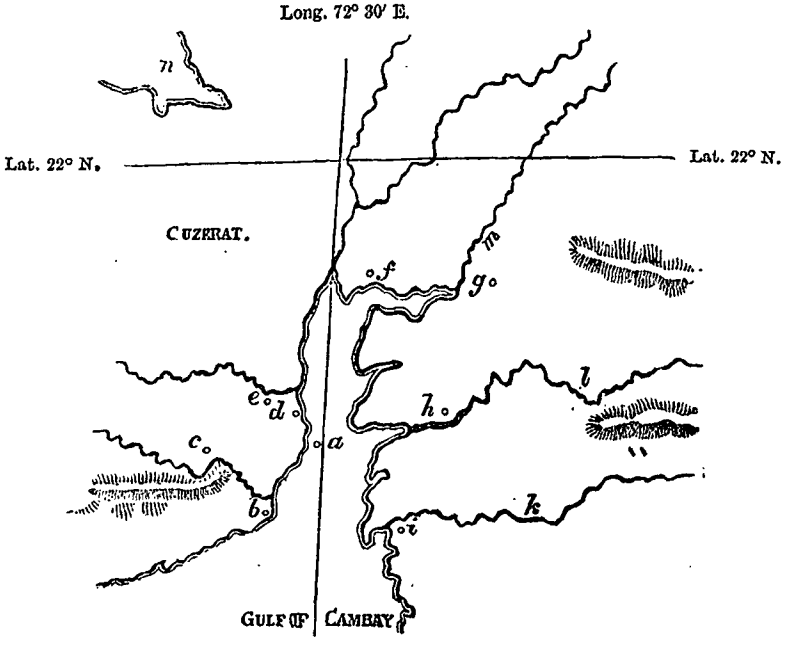
[This memoir was communicated to the Geological Society of London in July 1845, and is reprinted from the Journal of the Society. In addition to the fossils herein described the reader is referred to the figures and descriptions in the 'Fauna Antiqua Sivalensis' of *Mastodon Perimensis* (Plates xxxviii., xxxix., and xl.), *Rhinoceros Perimensis* (Plates lxxv. and lxxvi.).—ED.]

[2] This communication was read on Tuesday, 24th June, 1845.

the statement is founded; and as the Geological Society possesses the largest collection of Perim Island fossils to which I have had access, including remains of most of the species to be noticed in the sequel, the pages of its journal are the fittest place for this communication, the main object, indeed, of which is to do justice to the meritorious labours of Captain Fulljames, of the Bombay Engineers, one of the earliest and most successful explorers of the ossiferous beds of Perim Island. This is the more called for, as considerable delay has occurred in the description and determination of the remains which that officer collected and transmitted to England several years ago.

FIG. 14.

MAP OF THE DISTRICT NEAR PERIM ISLAND.



References.

a. Perim Island.	*e.* Bhownuggur.	*i.* Surat.
b. Gopenaut.	*f.* Cambay.	*k.* Tapti River.
c. Politana.	*g.* Baroda.	*l.* Nerbudda R.
d. Gogah.	*h.* Baroche.	*m.* Mhye R.
		n. Gulf of Gutch.

Note.—Between the Nerbudda and Tapti rivers (*k* and *l*) is the river Keem, the mouth of which is seen, but whose course is not indicated on the map.

Perim[1] is a small island, situated in lat. 21° 31′, in the Gulf of Cambay, nearly opposite the estuary of the Nerbudda

[1] Captain Fulljames, Journ. Asiat. Soc. of Beng., vol. v. p. 289.

River, and separated about 500 yards from the coast of Kattiwar in Guzerat, by a channel which Captain Fulljames states to be 75 fathoms deep. The island is about three miles in circumference, being from one and a half to two miles in length, and in breadth one half to three-quarters of a mile. The only particulars regarding its structure, with which I am acquainted, have been given by Captain Fulljames and Dr. Lush.[1] The highest point of the land is said to be not more than 60 feet above high-water mark. The western side presents cliffs of conglomerate, of about 30 feet above the sea, 'the upper strata being of compact sandstone, all perfectly horizontal.'[2] Captain Fulljames describes the order of succession, commencing from the surface, as thus:—

1. Loose sand and gravel.
2. Conglomerate, composed of sandstone, clay, and silex.
3. Yellow and whitish clay, with nodules of sandstone.
4. Conglomerate, as above (No. 2).
5. Calcareo-siliceous sandstone, with a few fossils.
6. Conglomerate.
7. Indurated clay, more or less compact.
8. Conglomerate, being the principal ossiferous bed.

No precise measurement is given of these beds, but the deepest strata of conglomerate are described to be about 3 feet thick, although in general they do not run more than 18 inches to 2 feet, and for the most part are horizontal. 'On the western side of the island, however, the strata are much disturbed, being fractured and dipping at an acute angle to the east. On the southern end of the island, sandstone appears below the fossil stratum of conglomerate, dipping to the north at an angle of 25°.' 'Capital fresh water is procurable on the island, rising from 20 feet below the surface; it is found below the stratum of sandstone.'[3] Dr. Lush states that 'proceeding from the south point towards the eastward, layers of kunkur are met with below the sandstone.' He also adds that shells and other fossils are found in the conglomerate, besides the osseous remains. But none of those shells are to be seen in the specimens to which I have been able to refer in the Geological Society's collection or at the British Museum.

Our information regarding the geological structure of both sides of the Gulf of Cambay is at present exceedingly imperfect; but much may be expected when the unpublished researches of the lamented Malcolmson are brought out, as he is known to have carefully determined the succession

[1] *Loc. citat.* Lush, idem, vol. v. p. 767.

[2] Lush, *loc. citat.*

[3] Fulljames, *loc. citat.*

and age of the tertiary beds along the coast of the northern Concan. In regard to what is known, Dr. Lush describes the sandstone of Bombay as appearing as Mahim, Seergaum, and Danu in horizontal strata, and 'evidently above the trap.' At Gundavie the shell sandstone disappears, and beds of clay and kunkur present themselves in the line of section from Gundavie to Surat. From this point to the Keem River nothing is seen but the 'black cotton soil;' on the right bank of the Keem, sandstone and conglomerate are exposed, according to Dr. Lush, in the following order:—

Section on the Right Bank of the Keem.

1. Alluvial soil with masses of conglomerate	6 feet
2. Horizontal beds of sandstone in thin layers	3 feet
3. Sandstone	5 feet
4. Coarse conglomerate (bed of the river).	

Respecting the Kattiwar coast, nearest which Perim Island is placed, Dr. Lush mentions the conglomerate as reappearing at Gogah, close to the island, where masses of the rock containing shells are dug out of the beach. This conglomerate appeared to him to contain no fragments of trap, although the central ridge of Kattiwar, including the hill of Politana, is composed of trap, which is also seen at Bhownuggur.[1] Captain Fulljames states that he has found 'a similar formation to that of Perim all along the coast from Gogah to Gossnath Point, where a firm sandstone is quarried, and of which the splendid Sráwak temples of Politana[2] are built.' Captain Fulljames, in a separate paper,[3] gives an account of the strata passed through, in an experimental boring at the town of Gogah. Of the 320 feet mentioned in the section, the uppermost 74 include of sand and gravel, 11 feet; stiff black clay, 6 feet; sand and clay, 10 feet; soft sandstone, alternating with thin seams of different coloured clays, sand, and gravel, 13 feet; and lowermost, a very hard siliceous sandstone, 9 feet thick. The inferior portion of the section is composed of a great bed of dark clay, which has been penetrated down to 246 feet, containing pyrites and broken shells. The whole of this mass appears to be above the conglomerate, but it is not shown whether the absence of the clay deposit at Perim is owing to denudation or to its upheaval before the clay on the coast was deposited. Captain Fulljames states that he had discovered fossil remains, like those of Perim Island, down the coasts towards Gossnath, and in a similar formation.

The first announcement of the Perim fossils is given in a

[1] Dr. Malcolmson, however (vide *postea*, p. 404), mentions the occurrence of trap pebbles in these same tertiary beds.

[2] Pattitona (of Fulljames).—[Ed.]

[3] Jour. Asiat. Soc. of Beng., vol. vi. p. 787.

communication, dated 17th April, 1836, by Baron Carl von Hügel,[1] in which he mentions their having been discovered by Dr. Lush. Among the remains which he enumerates are bones of the *Mastodon latidens*, the core of the horn of a species of Bos, the head of a boar, and a rodent. Captain Fulljames concedes the priority of discovery to Dr. Lush; but immediately after followed up the inquiry by more extended researches, commencing in April of the same year; and it is to him that we are indebted for the greater part of the Perim fossils, which are to be found in the Museums of the Asiatic Societies of Calcutta and Bombay, and of the Geological Society of London. Among those which he first met with he mentions 'teeth of *Mammoth*, *Mastodon*, *Palæotherium*, *Hippopotamus*, *Rhinoceros*, and a number of other smaller animals; elephant's tusks; the head of some large saurian animal; tortoise; one half of a deer's foot; and a shell in siliceous sandstone.' In the collection which Captain Fulljames sent to the Asiatic Society of Calcutta, Mr. James Prinsep[2] enumerates 'many jaws of the *Mastodon* in fine preservation; also teeth or jaws of the *Hippopotamus*, *Elephant*, *Rhinoceros*, a large animal assimilating thereto (*Lophiodon ?*), *Sus*, *Anthracotherium* (*?*), *Deer*, *Ox*, many vertebræ and unidentified bones and horns; *Tortoise* fragments, and a peculiarly perfect saurian head.'[3] These identifications are not to be considered, in several of the instances, as more than approximative; for neither of these gentlemen profess to be familiar with the subject of fossil bones.

No further account of these remains has appeared in any of the Indian journals since that time. In 1840 Captain Fulljames sent his donation to the Geological Society, and about the same time some specimens from the same locality were presented by Miss Pepper to the British Museum.

Judging from the matrix which adheres to them, the Perim fossils seem to be embedded, in most cases, in a calcareo-ferruginous conglomerate, composed of nodules of indurated yellow clay, cemented together by a paste of sand and clay. Some of them are attached to patches of a hard argillaceous sandstone. Many of them have had the matrix washed off by the action of the sea, and are in this case generally covered over with the remains of small species of Serpula and other recent marine shells. The mineral character of the bones shows that they are penetrated with siliceous infiltration, like a great portion of the Sewalik fossils; and in consequence they present a great degree of hardness. The same character

[1] Jour. Asiat. Soc. of Beng., vol. v. p. 288. (May 1836.)

[2] *Loc. citat.*, vol. v. p. 290.

[3] Jour. Asiat. Soc. of Beng., v. vi. p. 78. (Jan. 1837.)

holds in many of the osseous remains from the crag; like the latter, the Perim bones, under the action of the sea, wear down into a polished vitreous surface.

Dinotherium.

The first of these remains to be noticed is a fragment (Plate VI. fig 3) consisting of the posterior half of one of the inferior molars of a species of *Dinotherium*. The correspondence of the specimen with the teeth of the large European species is so complete in the form of the gable-shaped grinding ridge, its transverse direction, and the reflected marginal bulges into which it swells out on either side, together with the characteristic crenulation of the edge, that there can be no doubt of its belonging to the genus *Dinotherium*. The peculiar 'talon' or heel ridge is developed in the same degree and with a like amount of crenulation along its edge. The fragment is represented in section in Plate VI. fig. 3, the internal structure exhibiting the same agreement with that of the European *Dinotherium* (fig. 4) indicated by the external form. The centre is occupied by a rhomboidal core of arenaceous matrix marking the form of the unossified pulp nucleus. I have compared it minutely with a corresponding section of the same tooth (the penultimate of the lower jaw) of *Dinotherium giganteum* (fig. 4) from Eppelsheim; and the only perceptible difference is, that the angle formed by the ridge of the ivory is more acute, and the enamel thicker in the Indian than in the European form. Perhaps no conclusion can be safely drawn from this observed difference of angle in the ivory ridge; as it may be a peculiarity of the individual. The greater thickness of enamel is probably of more importance, and may represent a mark of specific distinction. The specimen, however, is much too defective to warrant any opinion in regard to the relations of the Perim fossil to the European species, except that it was quite as large as the *D. giganteum*. We are fortunately able to determine the position of the tooth in the jaw with some confidence. The upper grinders in *Dinotherium* have a long low basal ridge in front and behind; while the same teeth in the lower jaw have hardly any ridge in front, and the hind one is considerably more developed than in the upper grinders, so as to form a strongly marked 'talon' or heel. The Perim fossil exhibits this heel of large size, while the presence of an impression on the posterior surface proves that there was a tooth behind it. It, therefore, belonged to the penultimate molar of the lower jaw, and apparently to the left side.

In short, there can hardly be a doubt about the specimen belonging to a species of *Dinotherium*. The only question

DESCRIPTION OF PLATE XXXIII.

Bramatherium Perimense and Dinotherium Indicum.

Fig. 1. Fragment of left side of upper jaw of *Bramatherium Perimense*, presented to the Geological Society by Capt. Fulljames, showing the three premolars, and below them the broken remains of the first true molar. The figure is two-thirds of the natural size, and has been reproduced from a drawing by Mr. Scharf in the Quart. Journ. Geol. Soc., vol. i., Plate XIV., fig. 3. (See page 399.)

Fig. 2. Shows the rugous surface of the enamel on the second premolar of the same specimen, of the natural size.

Figs. 3 and 4. Another fragment of upper jaw, left side, of *Bramatherium Perimense*, containing the last premolar (at upper end of figures) and the three true molars. The specimen was referred to Dr. Falconer by Major Jervis, and is copied two-thirds of the natural size from the original drawing by Mr. Scharf in the Quart. Journ. Geol. Soc., vol. i., Plate XIV., figs. 4 and 4 *a*. (See page 400.)

Fig. 5. *Dinotherium Indicum*. Fragment of left half of lower jaw containing nearly the whole of the adult series of five molars *in situ*. The specimen is among the Perim Island fossils presented to the British Museum by Miss Pepper. The figure is one-fourth of the natural size, and has been copied from a drawing by Mr. Ford in Plate XXXV., fig. 6, of the Fauna Antiqua Sivalensis. (See page 404.)

Fig. 4.

Fig. 3.

Fig. 1.

Fig. 2.

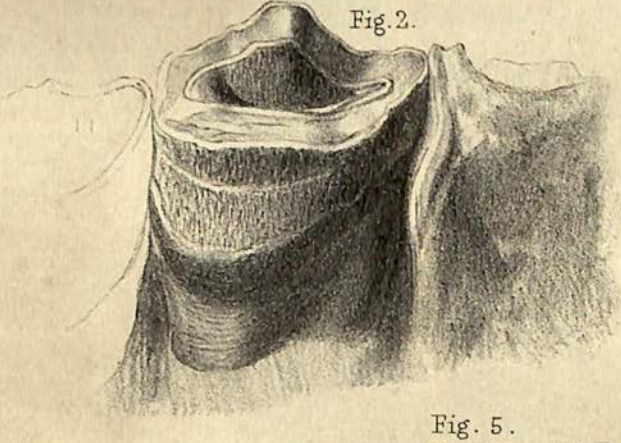
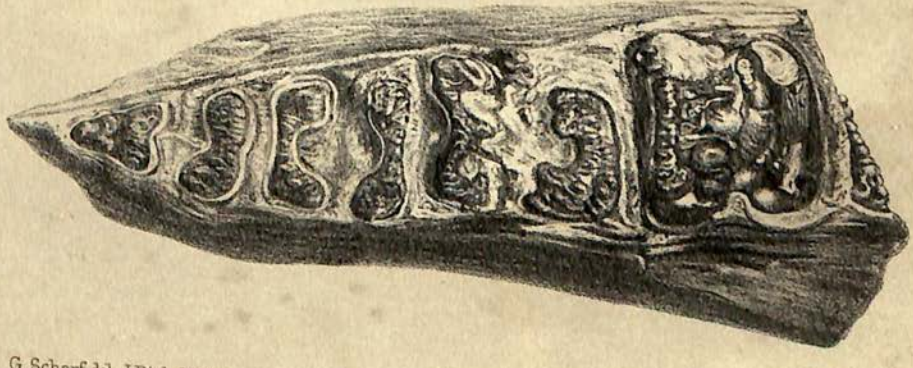


Fig. 5.



G. Scharf del. J. Dinkel lith.

1-4. Bramatherium Perimense.

5. Dinotherium Indicum.

W. West imp.

which can arise is in regard to the correctness of the locality whence the specimen is said to have come. It was presented to the British Museum by the lady whose name is mentioned above, as a Perim Island fossil, along with teeth specimens of a species of Mastodon known to be found in the Perim deposit. Mr. König, the eminent conservator of the Palæontological department, who had early recognized the generic relations of the fossil, is confident about the donor and the mentioned locality. An additional confirmation is met with in the mineral condition of the specimen. It exhibits the silicified appearance, which is so prevalent in the Ava, the Sewalik, and Indian fossils generally. The ivory core is fissured into a vast number of radiating minute segments which have been re-cemented by a siliceous paste (as has happened to certain agates), and the whole of the structure —enamel and ivory—has become so thoroughly penetrated with siliceous infiltration that it resists the knife and takes on the highest degree of vitreous polish in the section, while the external surface of the enamel, from the same cause, presents an opaline appearance. All the Eppelsheim specimens of *Dinotherium* which I have had an opportunity of examining are, on the other hand, unsilicified, softer, and of less specific gravity. In section their ivory cuts under the knife, and yields a dull earthy surface; while the harder enamel takes on but a very imperfect polish. This circumstance strongly confirms the Indian origin of the fossil. It is very possible that the large animal—'assimilating to the Rhinoceros (*Lophiodon ?*)'—mentioned by Mr. James Prinsep in the quotation above given, may also belong to *Dinotherium*. This conjecture is thrown out for the guidance of those connected with the Museum at Bombay and that at Calcutta, who have access to the original specimens. What we know at present must serve in a great measure as an index merely to further inquiries. I would suggest in the meantime designating the Perim fossil provisionally by the specific name of *Dinotherium Indicum*.

The following are the dimensions of the fragment compared with those of the same tooth of the *Dinotherium giganteum* from Eppelsheim.

	Perim Fossil	Eppelsheim Specimen
	Inches	Inches
Length of penultimate molar, lower jaw	—	3·75
Width of ditto, at the posterior ridge	3·1	2·75
Length in section of the posterior ridge of ivory, at base	1·5	1·75
Height of ditto	·63	·63
Thickness of the enamel	·25	·19

The fossil is represented in the figure about two-thirds of the natural size (Plate VI. fig. 3).

Giraffe (*Camelopardalis*).[1]

The specimen is a fragment comprising the posterior half of the second cervical vertebra of a Giraffe, a good deal mutilated. It shows the characteristic form of the body of the vertebra in this genus, and the cup-shaped articulating surface for the head of the third cervical vertebra. The upper half is wanting, and the posterior oblique processes are broken off. Along the middle of the body there is a well-marked longitudinal ridge, corresponding exactly in form and development to that mentioned as characterizing the third cervical vertebra of the *Camelopardalis Sivalensis* described in the 'Proceedings' of the Geological Soc. (See *antea*, p. 199). The same remark applies to the lateral ridges of the body, which are decurrent from the inferior transverse processes, terminating at the posterior end of the bone in thick expansions. This part of the vertebra is differently formed in both respects in the existing species. The same resemblance is further shown by the spinous process, the projecting part of which, as in the Sewalik specimen, is placed lower down on the arch than in the living species. The mutilated condition of the fragment prevents the form of this process from being well ascertained; but the very low position and shape of the most salient part determines the vertebra to have belonged to the second of the neck series. There is enough remaining to indicate that there was a like correspondence with the Sewalik fossil in the curve of the body on its under surface, which is more arched than in existing Giraffes. The specimen is so weathered and abraded as to present only few points for measurement; but such as may be taken indicate the closest agreement between the fossils:

	Perim Island Fossil	Sewalik Fossil
	Inches	Inches
Greatest width at the posterior end of the body between the transverse processes	3·1	3·1
Vertical diameter of articulating cup	2·1	2·
Transverse diameter of ditto	2·1	2·

The Perim fossil, like the Sewalik one, is proved to have belonged to an adult and even aged animal, by the marked

[1] The specimen is now in the British Museum (Cat. No. 39,748). It is also figured in the Quart. Jour. Geol. Soc., vol. i. Plate xlv. fig. 5, and in an unpublished plate of the 'Fauna Antiqua Sivalensis' (E. 2).—[Ed.]

relief of the ridges, the depth of the muscular depressions, and especially by the circumstance that the posterior articulating surface is completely synostosed with the body of the bone, which is not the case in young animals. With this united correspondence in form, size, and other particulars, I have little hesitation in referring the Perim Island fossil to the second cervical vertebra of the *Camelopardalis Sivalensis*. This specimen is from the collection sent by Captain Fulljames to the Geological Society.

Bramatherium. Pl. XXXIII. figs. 1, 2, 3, 4.

The next of these remains to be noticed are of great interest, as they appear to indicate a large and peculiar form of Ruminant, nearly equalling the Sivatherium in size, but at the same time essentially different. The remains consist of two fragments of the left side of the upper jaw, including the entire series of the superior grinders.[1] Although probably of the same species, they are certainly not derived from the same individual. The first fragment (fig. 1) is from the collection sent by Captain Fulljames to the Geological Society. It contains the three false or premolars nearly perfect, together with the broken remains of the first true molar. The surface of the enamel (fig. 2) shows the rugosely furrowed character, which is found in the Sivatherium; but the whole of the teeth in the fossil are at once distinguished from those of that genus by the absence from all of them of the sinuous plaited flexures, which the inner crescent of enamel presents in it; they also want the basal collar or 'burr' on the inside, which is seen in those of *Sivatherium*. With these discrepancies, which are of considerable importance in the Ruminantia, from the constancy of such modifications in the different groups of this order, the premolars of the fossil correspond in general form, and in

[1] The following remains of *Bramatherium* are described by Dr. Falconer in the Catalogue of the Museum of the Asiatic Society of Bengal:—

No. 38. Perim Collection. Lower jaw, left side, in two pieces, containing 2nd and 3rd true molars, truncated in front and behind.

No. 39. Lower jaw, left side, containing four molars, worn, but more or less broken.

No. 40. Proximal ungual phalanx of left leg. It corresponds almost exactly in size and in proportion with the same phalanx of the fore leg of existing Giraffe in the Asiatic Society's Museum.

No. 41. Horn of the Bramatherium (?) resembling the horn of Sivatherium, figured in Journal of the Asiatic Society, but different. This is a specimen of very great interest.

No. 42. Portion of the shaft of a long bone, apparently the tibia, left side, of a ruminant resembling the Giraffe and hence inferred to be of Bramatherium from its larger size.

For an account of the bones of the anterior and posterior extremities of *Bramatherium* the reader is also referred to the description of an unpublished plate of the Fauna Antiq. Siv. (F.)—[Ed.]

the relative proportion of width to length with those of *Sivatherium*. The only other genus of Ruminants which shows the peculiar rugose enamel furrowing, in a marked degree, is the Giraffe, which agrees with the Perim fossil in the simple direction without fold, of the inner crescent of enamel. But, in this genus, the upper premolars are distinguished from those of all other Ruminants by their great excess of width compared with their length. In this respect, and further in being considerably more oblique, both in form and in their relative position in the jaw, these teeth in the Perim fossil differ from those of the Giraffe. The dimensions of the fossil contrasted with those of the *Sivatheriun giganteum*, and of the skull of an adult male Giraffe in the collection of the College of Surgeons, are as follow :—

	Perim Fossil No. 1.	Sivatherium giganteum.	Male Giraffe
	Inches	Inches	Inches
Length of the three premolars	·4	4·5	2·9
Length of the 1st premolar	1·5	1·75	·9
Width of the 1st ,, ...	1·3	1·63	1·1
Length of the 2nd ,, ...	1·4	1·5	1·
Width of the 2nd ,, ...	1·5	1·75	1·1
Length of the 3rd ,, ...	1·25	1·75	1·
Width of the 3rd ,, ...	—	1·9	1·2
Length of the 1st or antepenultimate true molar .	1·6	1·6	1·33

The second specimen (figs. 3 and 4), (for an examination of which I am indebted to the kindness of Major Jervis, of the Bombay Engineers), is also from Perim Island, and shows the hindmost premolar, together with the three back or true molars nearly perfect. Like the premolar of the other specimen, these teeth, besides being smaller, differ from their equivalents in *Sivatherium giganteum*, by the absence of the flexuous direction of the enamel, and of the basal ridge at the inside. In these particulars, and also in the presence of a minute or rudimentary cone of enamel, on the inner side at the base, between the barrel divisions of the teeth, but attached only to the posterior lobe, they correspond with the other molars of the Giraffe. But the anterior pillar of enamel, on the outer surface of the front half of these teeth, is considerably thicker in proportion in the fossil than in the Giraffe ; while the outer surface of the posterior half is more expanded in length, and is more hollow than in the latter genus. A still more important difference is, that, in the fossil there is no tendency to a basal mammilla or enamel lobe at the outside between the barrel divisions of the two back-

most molars, as in the larger fossil Giraffe of India (See *antea*, p. 201, and Pl. XVI. figs. 5, 5 *a*, and 6); while the middle of each of these divisions at the inner side is so compressed vertically as almost to present an obsolete or indistinct form of keel. The following are the comparative dimensions, as in the case of the previous specimen:—

	Perim Fossil No. 2.	Sivather. gigant.	Male Giraffe.
	Inches	Inches	Inches
Length of the series of three back molars	4·63	5·	3·9
Length of the 1st molar	1·6	1·63	1·33
Width of the 1st „	1·75	2·	1·97
Length of the 2nd „	1·75	2·	1·37
Width of the 2nd „	1·9	2·	1·37
Length of the 3rd „	1·6	2·	1·37
Width of the 3rd „	—	1·75	1·37

It is not necessary to follow up the comparison of the fossil teeth with those of the *Bovidæ*, *Cervidæ*, and other families of the order, from all of which they appear to be more removed than from the *Sivatherium* and *Giraffe*. The molars of the Ruminantia generally are formed so much upon the same plan, that it is not easy to draw sufficient generic distinctions from them alone. The characters presented by these Perim fossils, so far as they go, certainly distinguish them from the *Sivatherium*, and also from the Giraffes, fossil and recent; but their nearest affinity appears to be with the latter genus, and they probably belong to the same family. The materials presented here, as in the case of the Dinotherium, are much too scanty at present for any conclusive opinion on the subject. Meanwhile, under the conviction of the generic distinctness of the Perim Ruminant, I propose considering it as a genus under the name of *Bramatherium*,[1] with the specific title of *B. Perimense*, to mark the rich and interesting fossil locality where it was found.

The Dinotherium, Giraffe, and Bramatherium, are the only Perim fossils which it is intended to particularize by description in this communication. But Captain Fulljames's collection includes specimens of a great many other forms, which prove that the clay conglomerates of the Gulf of Cambay contain entombed in them the remains of a very extensive and varied fauna. Among them there occurs one species of

[1] The name *Sivatherium*, derived from the Hindoo God *Siva*, having been admitted for one great fossil Ruminant from India, *Bramatherium*, derived from the God *Bramah*, may conveniently be applied to another; the ordinal relationship of the two will thus be easily remembered, together with their common Indian origin.

Mastodon, one of Elephant, a large species of Rhinoceros, Hippopotamus, Sus, Equus, several species of Antelope, Bos, two species of Crocodile, one of which is of the Gavial type; several forms of freshwater Tortoises, with fish vertebræ two and a half to three inches in diameter. These will be noticed in detail, in the work upon which Captain Cautley and myself are engaged, on the fossil fauna of the Sewalik hills. The principal point of interest about them requiring mention on this occasion is, that the mass of the Perim fossils belong to the same genera and species which are found in the Sewalik hills, and in the ossiferous beds of the Irrawaddi in Ava. We have thus conclusive proof that, in the later tertiary period, as at present, one and the same vertebrate fauna ranged from the banks of the Irrawaddi, on the eastern side of the Bay of Bengal, 1,700 miles up along the foot of the Himalayahs to the Indus, where it escapes from these mountains, and thence across the continent to the western side of India. We are now getting the first glimpse of the evidence, regarding the range and distribution of the species. Some, as at present, were common over the whole extent of country, while others appear to have been limited to, or had their force of development in, a particular tract. The prevailing species of Mastodon from Perim is identical with one of the forms described by Mr. Clift, under the name of *M. latidens*, in his excellent memoir in the Geol. Transact., 2nd. ser. vol. ii. p. 371, this nominal species appearing to include two very distinct forms. One of these (Mr. Clift's, Pl. XXXVII. figs. 1–4) seems to have been common on the western side of India and in Ava, while it is but rarely found in the Sewalik hills. The Perim *Sus* is identical with a Sewalik species (*Sus Hysudricus*, Falc. and Caut.); and a like agreement has been noticed as holding with one species of Giraffe. The Dinotherium and Bramatherium have not yet been observed amidst the fossils of the Sewalik hills, while the gigantic Tortoise (*Colossochelys Atlas*) ranged from the Sewalik hills to the Irrawaddi.[1] The Hexaprotodon form of Hippopotamus occurs in Perim Island, Ava, the valley of the Nerbudda River, and the Sewalik hills.

I have had occasion, in more than one instance, in joint communications with Captain Cautley to the Geological Society, to refer to the singular richness of the ancient fauna of India, in mammiferous forms. As a general expression of the leading features, it may be stated that it appears to have been composed of representative forms of all ages, from the oldest of the tertiary period down to the modern, and of all

[1] There are fragments of this great Chelonian among the fossils brought by Mr. Crawfurd from Ava.

the geographical divisions of the old continent grouped together into one comprehensive fauna in the countries along the valley of the Ganges. The Dinotherium of the miocene period of Europe was, till now, a notable exception; but the fossil described in the preceding pages shows that ancient India was not without a representative of this most remarkable genus. In addition to most of the known types of Ruminants we have now evidence that the same country had, in the Sivatherium and Bramatherium, at least two colossal forms of this order.

In regard to the precise determination of the age of the ossiferous deposits of India, the problem still remains to be solved. The western coast of the peninsula will, in all probability, furnish the most certain and numerous data for its solution; as we may expect there to find deposits and organic contents corresponding to the numerous alternations of upheavement and submergence which the land on that side of the continent has undergone. Fossil remains of Elephant, Hippopotamus, Equus, &c., were discovered by Dr. Spilsbury,[1] in the valley of the Nerbudda, near Jubbulpoor, in a bed of limestone capped by a thick mass of basalt, and traces of mammiferous remains have been found in other parts of the basaltic district of central India. Extensive lacustrine deposits disrupted and altered by the same igneous rock have been met with over a wide extent of the Deccan, containing the same species of *Paludina*, *Physa*, *Limnea*, *Unio*, and *Cypris*.[2]

Reasoning from these facts, Dr. Malcolmson was led to the inference 'that the part of the Vindhya range near Mandoo was elevated during the same comparatively recent epoch as the Sichel hills, between the Godavery and Tapti, the Gawulgurh range, and the Satpoora mountains, south of the Nerbudda.' He adds also the following startling generalization: 'Over all these tracts, then, I am justified in believing that at one time extensive lakes and marshy plains existed, full of the ordinary forms of lacustrine life. The precipitous and thirsty mountain ranges which intersect India, and which now rise bare and burnt up in inaccessible cliffs, which for months of every year hardly afford water for the birds of the air, must then have exhibited vast plains, full of freshwater lakes and marshes, on the muddy shores of which multitudes of gavials, crocodiles, and tortoises must have preyed; and amidst the rank luxuriance of the bordering vegetation the *Mastodons*, *Hippopotami*, *Bisons*, and *Sivatheria*, must have

[1] Jour. Asiat. Soc. of Bengal, vol. ii. p. 583.

[2] Malcolmson, Geol. Trans., series 2, vol. v. p. 570.

ranged, whose bones are now found so abundantly scattered over India.'[1] Unfortunately, this excellent observer's researches on the Gulf of Cambay have never been published; but in a note appended to the paper quoted above he mentions the occurrence of trap pebbles in the tertiary sandstones of Perim Island and Kattiwar (see *antea*, p. 394), and in the cornelian conglomerates of Rajpeepla and Broach, which are said to be remarkably altered by the intrusion of igneous rocks of a late date.

Supplementary Observations.—Since the preceding remarks were in type I have had occasion to examine some other Perim Island fossils presented to the British Museum by Miss Pepper, one of which has furnished additional and most unequivocal evidence of a huge Indian species of Dinotherium. The specimen is a superb fragment of the left half of the lower jaw, containing nearly the whole of the adult series of five molars *in situ*.[2] The contour of the body of the jaw is shown in the most perfect state of preservation, the fossil having fortunately been mineralized by means of a very hard siliceo-ferruginous infiltration. But it has evidently been long rolled about on the sea-beach as a boulder, so that the crowns of the whole series of molars have been hammered off nearly level with the alveolar margin of the jaw; the surface of the fossil is jet black, and almost all of the matrix has been cleared away, probably by the long-continued action of the sea, which has given it a semi-vitreous polish. That it had latterly been in the sea is distinctly proved by adherent patches of recent marine shells identical with those found on others of the Perim fossils; and the testaceous remains being white, pearly, and fresh-looking, are seen in marked relief upon the black surface of the fossil. The symphysis of the jaw is broken off about 2½ inches in front of the anterior premolar, and the bone is truncated behind exactly opposite the point where the coronoid margin of the ramus begins to rise up, the fracture passing through the middle of the last molar, the anterior ridge of which is visible *in situ* in the jaw.

The dimensions given below will indicate most distinctly the characters by which this fossil differs from the jaw of the *D. giganteum* of Kaup. In relative length, the two agree very closely, the four anterior molars measuring but half an inch more in the Indian than in the European species. But the other proportions are very different. The depth of the jaw measured to the alveolar margin of the second premolar, where the deflexion of the symphysis begins alike in both, is

[1] Malcolmson, Journal Bombay Geographical Society, vol. for 1841–1844, p. 371.

[2] See Plate xxxiii. fig. 5, copied from Fauna Antiq. Siv., Plate xxxv. figs. 6 and 6 *a*.—[Ed.]

9·2 inches in the former, while it is but 6·9 in the latter, and at the back of the third tooth or first true molar, 8·7 inches to 6·2 inches. The Perim fossil exhibits a like excess of dimensions in relative thickness, the jaw measuring 5·1 inches in diameter under the second premolar, and 6·4 inches at the middle of the penultimate molar, while in the European species the corresponding dimensions are respectively 4 and 5 inches. In consequence of this great depth and thickness, the jaw of the Indian fossil approaches very closely the massive and turgid form seen in the typical Mastodons, such as the *M. giganteus*; while that of the European Dinotherium is comparatively much thinner and more compressed. The inner side of the jaw in the latter is very flat, differing in this respect widely from the Mastodons generally; in the Perim fossil this flatness is much less, not exceeding that of the *Mastodon giganteus*, and, behind, the body of the jaw bulges out on either side, so as to yield nearly a circular outline in section, and exactly to represent the form in the American Mastodon. This resemblance is so great, that in the absence of the crowns of the teeth, and from its huge proportions, the fossil, when presented to the Museum and up to this time, has always been regarded as the jaw of a Mastodon. The relationship indicated by the shape of the jaw is further borne out by the form and structure of the penultimate lower tooth, as described in the preceding part of this paper. The enamel, which is thinner in the *D. giganteum*, is as thick in the Indian species as in the lower penultimate of the American Mastodon; the outline of the ivory ridge beneath the enamel is the same in both; the crown ridges have the same transverse, continuous, crenulated, and trenchant form; and what is most important and significant of all, the hind talon, in respect of form, amount of development, and the characteristic crenulation of its edge, is so precisely similar, that this part in the one exactly represents the corresponding part of the same tooth in the other. The same direction of affinity is further indicated by the nearly horizontal line of protrusion and horizontal plane of wear in the teeth, by the form of the ramus, coronoid process, and angle of the jaw, and by the absence of antero-posterior curvature in the outline of its lower surface, in all of which particulars the American Mastodon deviates widely from its congeners, and from the Elephantine type generally, and approximates towards the Dinotherium. This tendency is also shown in the very reduced formula of the teeth-ridges, in the deflexion of the symphysis, its thick bluff termination, and in the inferior tusks. I shall soon have occasion in another place to follow this subject at greater length, and in

the meantime must content myself with the simple statement, that the North American Mastodon and the Indian Dinotherium are the nearest connecting forms of the two genera yet known, and that their relationship is far from being remote, perhaps even nearer than that of the American Mastodon to the Indian Elephant or the Mammoth.[1]

The deflection of the symphysis commences immediately behind the second molar, as in the *Din. giganteum*, and it is evidently produced into a great bluff mass, bent downwards as in that species. The section at this point does not include any part of an inferior tusk, or of an alveolus for it; but Dr. Kaup[2] tells me that the large tusks of the Eppelsheim species, with their alveoli, always terminate considerably in front of the anterior premolar. There is no reason, therefore, to conclude that the Indian had not tusks resembling those of the European species; and although there is no direct evidence to the point, everything in the construction of the symphysis goes to support the presumption that there were tusks. The posterior mentary foramen is of large size, and situated at the outside under the anterior premolar, exactly as in the Eppelsheim fossil, but at a greater distance from the alveolar border of the jaw. It is much larger than the foramen seen in the cast of the Eppelsheim lower jaw; but no faith can be put in the dimensions of a foramen measured on a cast.

In regard to the teeth, nothing is seen of their crowns, which have been broken off close to the alveolar margin; but the bony partitions between five teeth are distinctly visible, showing the usual complement in Dinotherium, and proving that the fossil was derived from an adult animal. These five teeth consist of two premolars and three true molars. They diminish in width from the backmost forwards, as in the European species. The anterior premolar has two lobes, the front one being compressed and sharpened off forwards into a cuneiform edge, the rear lobe being shorter and broader. This tooth is upwards of half an inch longer than that belonging to the jaw of the great specimen figured by Kaup. The second premolar is nearly square in outline, but wider behind. It appears to have had two ridges, and four fangs. The third tooth or first true molar presents a length of 4 inches by 2·8 of extreme breadth; while that of

[1] See *antea*, p. 85.—[Ed.]

[2] I have had the advantage, while engaged on the examination of this fossil, to benefit during his present residence in London, by the intimate knowledge of the structure of the Dinotherium, possessed by this distinguished palæontologist, the founder of the genus. Dr. Kaup was at once convinced of the generic relations of both the fossils, but he is in nowise responsible for any of the opinions here advanced regarding the distinctness of the species, or its affinities.

the Eppelsheim cast measures 3·6 by 2·6. We have in this excess of length conclusive proof that the Indian, like the European species, possessed the remarkable character of having the first true molar three-ridged, and more complex in its form than the two backmost grinders. The crown is so utterly mutilated as to afford no evidence regarding the form of these ridges. The second or penultimate true molar is nearly square in its plan outline, but more than half an inch longer and wider than in the European species. The tooth specimen described in the body of this paper was inferred to be the penultimate inferior, and it was probably derived from a female or small-sized individual. The remains in the jaw appear to indicate that this tooth was two-ridged, with a talon as in the European species. Of the third and last molar only the anterior half remains, and we have no direct proof how many ridges it bore; but the number was most probably two, with a talon, as in the European species. The portion which remains presents two distinct and slightly divaricating fangs, indicating, among many others which could be added, another character of resemblance to the North American Mastodon.

The following are the dimensions of the fossil compared with those of a cast of the jaw of the great head specimen, supposed to have been a male, figured and described by Kaup :—

	Mastodon giganteus.[1]	Dinotherium Indicum, from Perim Island.	Dinotherium giganteum of Eppelsheim.
	Inches	Inches	Inches
Length of the fragment	—	17·	—
Ditto of the four anterior teeth	—	13·5	13·
Ditto of the first premolar	—	3·5	2·9
Width of ditto behind	—	2·2	2·2
Length of 2nd ditto	—	2·9	3·3
Width of ditto behind	—	2·6	2·7
Length of 3rd or first true molar tooth	—	4·	3·6
Width of ditto behind	—	2·8	3·
Length of 4th tooth (2nd true molar)	—	3 9	3·3
Width of ditto	—	3·5	2·9
Depth of jaw to alveolar margin at the 2nd premolar	7·5	9·2	6·9
Ditto at 3rd tooth (1st true molar)	6·6	8·7	6·2
Width of jaw at 2nd premolar	5·7	5·1	4·
Ditto at the middle of 4th tooth (or penultimate true molar)	6·5	6·4	5·
Distance between the upper margin mentary foramen and alveolus of 1st premolar	—	3·6	2·2
Ditto from inferior margin to ditto	—	4·75	3·4

[1] N.B. The four measurements of *Mastodon giganteus*, given for comparison, are taken at points of the jaw corresponding to those of the *Dinotheria*.

The Dinotherium of Eppelsheim is known to range through a very wide difference of size, dependent on sexual or individual peculiarities, and several nominal species, chiefly founded upon this character, have been described by authors. But Dr. Kaup informs me that he now admits but two species, *D. giganteum* and *D. Kœnigii*, as he regards all the rest, such as *D. Cuvieri*, *D. Bavaricum*, *D. proavum*, &c., to be merely dwarfed varieties, or females of *D. giganteum*. M. de Blainville has arrived at nearly the same conclusion in his 'Ostéographie.' It would be unsafe, therefore, to found any opinion regarding the Indian fossil merely on a difference of size. But, in addition to the larger dimensions, the very remarkable peculiarities in the form of the jaw, indicated by its great depth in front, the excessive width, massive form, and circular outline in section behind, together with the absence of the flattening of the inner side, which is so marked in every specimen of *D. giganteum*, taken in conjunction with the very significant difference in the thickness of the enamel, appear to furnish the strongest evidence that the Indian fossil belongs to a distinct species. It is to be kept in mind, also, that all these differential characters tend, in a remarkable manner, in the direction of greater affinity with the *Mastodon giganteus*. In corroboration of this view, it deserves to be stated that of the numerous fossil Proboscidea discovered in India we[1] have found that all the forms are specifically distinct from those which occur in Europe. I have now no hesitation in regarding both the Perim fossils to belong to a distinct species of Dinotherium, larger than the *D. giganteum*, and more closely allied to the Mastodons, which, as proposed in the preceding pages, may be called *D. Indicum*.[2]

NOTE.—In the 'Athenæum,' No. 923, p. 662, there is an abstract of a paper by Mr. A. Bettington, read to the Royal Asiatic Society, on June 21 of this year, giving an account of a finely-preserved cranium of a huge Ruminant, found by that gentleman in Perim Island; I have repeatedly seen the specimen, which was exhibited at the anniversary meeting of the Geological Society on February 17 last; but as unpublished material, which I had no authority to quote, I have not felt at liberty to refer to it in the descriptions given in this paper. Mr. Bettington institutes a comparison of his fossil with

[1] In stating this, I use the plural pronoun *we*, intending to intimate that the opinion is one in which my colleague Captain Cautley also concurs.

[2] In 1857 remains of *Dinotherium* were discovered in the valley of the Indus, below Attock, by Lieut. Garnett, and identified by Dr. Falconer. See *postea*, p. 414.—[ED.]

the Sivatherium and Giraffe, and considers it, so far as the abstract above quoted indicates, to be distinct from both. The circumstance that this cranium and the fossils here described are from the same locality creates a strong presumption that they may belong to the same genus or even to the same species; but I am unable to say in how far the teeth agree, as I have not had an opportunity for making the necessary comparison. Mr. Bettington, as quoted in the abstract, appears to consider that, in addition to horn buttresses behind the orbits, there was a pair of recurved rear horns in his fossil, at the side of the occiput, placed as in the buffalo. This inference, if well founded, would be against the affinities here attributed to Captain Fulljames's fossil, should it prove to belong to the same species. Among the remains mentioned as having been found associated with this cranium by Mr. Bettington are species of *Mastodon*, *Rhinoceros*, besides several forms of Ruminants, *Crocodiles*, &c.

APPENDIX TO MEMOIR ON PERIM ISLAND FOSSILS.

I.—Description of a fragment of Fossil Bone from Perim Island, Gulf of Cambay, in the collection of Mr. Henry Duckworth, Liverpool (Labels 12 and 47). From Dr. F.'s Note-Book.

This specimen consists of a mutilated portion of the right ramus of the lower jaw, comprising the fang portions of one or more molar teeth; together with about two inches in length of the entire and sharp edge of the diasteme. The internal alveolar wall is broken off, and polished by rolling; the crowns of the teeth are also entirely wanting. The specimen is truncated in front through the diasteme; and behind, in a line with what is inferred to be the second molar, the surface of the bone has acquired a vitreous polish, and is covered here and there with white undetermined incrustations. The fragment is chiefly remarkable for the compressed character of the ramus, and for the great concave curve of the lower margin in front, which is deflected downwards in a bold curve intermediate between that of *Dinotherium Indicum* and *M.* (*Trilophodon*) *angustidens*. The compression of the ramus is too great for an adult jaw of *Dinotherium*, and the downward deflection greater than is met with in any species of *Mastodon*. The anterior end of the fragment is curved slightly inwards, to meet the corresponding opposite side; but no portion of the symphysis remains. Regarded from the anterior end, the section shows a deep compressed elliptical hole, considerably in advance of the mentary foramen, and which therefore cannot be regarded as the dentary canal, but rather the alveolus of a very large and solitary recurved incisor, as in *Dinotherium giganteum*, or deflected, as in *Mastodon angustidens*. The mentary foramen is situated posteriorly to the anterior fangs, and at about two-thirds of the

vertical height of the outer surface of the jaw. Part of the outer layers of the bone has recently been denuded from the external surface; the mentary foramen is of inconsiderable size. The specimen consists of two fragments, the larger of which bears the label No. 12, to which a smaller fragment (No. 47) was fortunately added, yielding the first indication of the downward deflection of the symphysial portion. The mentary foramen is of no great size; the diastemal edge is raised, and very sharp, and follows an outward direction, where the anterior part of the ramus commences to be bent inwards.

Unfortunately all evidence derivable from the crowns of the teeth as regards the degree of composition and complexity is entirely wanting. The principal dimensions are as follow :—

	Inches
1. Extreme length of the fragment taken at the inferior margin (as a chord to the arc)	7·75
2. Versed sine of the concave arc of the lower jaw, when rested upon the ends of the fragment	0·8
3. Vertical height of ditto, at anterior termination of the diasteme	5·0
4. Vertical height of the jaw, in a line with the anterior molar	5·1
5. Greatest thickness of the jaw behind	2·8
6. Ditto in a line with the mentary foramen	2·2
7. Length of the remains of the diasteme	2·2
8. Vertical height of the supposed alveolus, of the incisor	3·2
9. Transverse ditto	1·5

The supposed alveolus of the incisor is filled up with conglomerate matrix, and its definition imperfectly shown.

This is a very important specimen, and thin sections, both of the ivory of the teeth, and of the compact bone, ought to be taken for microscopical investigation. As an approximative opinion, I am inclined to consider it as of a Dinotherian form, and it may be, of a young *Dinotherium Indicum*; but the contour of the lower jaw in that species is so imperfectly known that nothing more positive can be asserted in regard to it.[1]

LONDON, 31 SACKVILLE STREET:
March 1858.

II.—MS. NOTE BY DR. FALCONER.—MICROSCOPIC EXAMINATION OF MR. TAIT'S SUPPOSED VERTEBRA OF DINOTHERIUM FROM PERIM ISLAND.

Vertical Section.—Viewed with $\frac{1}{8}$ inch object glass, the length of one of the cells of Purkinje is $\frac{1}{975}$ inch and the width $\frac{1}{3000}$. Their form is long and ragged, and attenuated at either end, like an insect with innumerable legs. The measurements of another cell were $\frac{1}{780}$ in. and $\frac{1}{4600}$. The calcigerous tubes are $\frac{1}{11700}$ of an inch apart. Seen in transverse

[1] Among other specimens from Perim Island in Mr. Duckworth's collection, Dr. Falconer identified remains of *Mastodon, Hippopotamus, Deer, Antelope, Crocodile,* and *Tortoise.* In another collection from Perim Island, forwarded by Dr. Buist, of Bombay, in 1860, Dr. Falconer identified remains of *Mastodon Perimensis, Rhinoceros, Bramatherium,* &c.—[ED.]

section their outline is oval with a diameter of $\frac{1}{5850}$ to $\frac{1}{3900}$. In some places the radiating calcigerous tubes are cut across, and take the form of numerous dots in the field, like the ends of ivory tubes, and under a low power have a moniliform or beaded appearance. The diameter of the concentric circles is about $\frac{1}{40}$ inch, there being from five to eight rings of cells in each circle.

XXIV. NOTE ON CERTAIN SPECIMENS OF ANIMAL REMAINS FROM AVA.[1]

PRESENTED BY JAMES CALDER, ESQ., V.P., TO THE MUSEUM OF THE ASIATIC SOCIETY.

BY HUGH FALCONER, M.D.

THESE specimens of Ava fossils were procured, with some difficulty, from the neighbourhood of Prome, where the collection by Dr. Crawfurd had been previously made. We may hope ere long to have a richer assortment, through the exertions of Major Burney; but in the meantime it may be interesting to the Society to know what individual fossils of the number have been identified with those taken hence by Dr. Crawfurd.

It must be premised that the following attempt at discriminating the animals to which the fossil bones belonged is submitted to the Society with great diffidence, and is confessedly imperfect. Had the means of comparison been more extensive, an accurate list might have been made out; but no recourse could be had to the skeletons of any *analogues*, and the only available sources of information were Cuvier's 'Ossemens Fossiles,' and Memoirs in the Geological 'Transactions,' by Buckland and Clift.

Further, this note does not profess to contain anything original, or to make any addition to the list of fossils from Ava already discovered.

The remains are confined to quadrupeds. There are no marine nor freshwater shells, nor any specimen of the deposit in which the remains are found; but it is believed to be the same diluvial formation in which the remains of mammalia are found in Europe and America.

The specimens consist of fragmental portions of bone; many of them coloured with iron. The fragments are mostly angular, and few of them bear marks of attrition.

[1] This note was communicated to the Asiatic Society, on April 20th, 1831, soon after Dr. Falconer's arrival in India, and was published in the 'Gleanings in Science,' vol. iii. p. 167, Calcutta. Although fragmentary, it is here reproduced, as it has been quoted by Kaup and other authorities.—[ED.]

Of the *Pachydermata* there are bones belonging to two genera, the Rhinoceros and Mastodon.

No. 1 *a*. Is a fragment consisting of a longitudinal and vertical section, of a molar tooth of a Mastodon, with a portion of the attached jaw, and a nearly entire fang. The characters are not sufficiently marked to determine the species, but it seems to approach most nearly the *Mastodon latidens* of Mr. Clift (Geol. Trans. vol. ii. p. 11).

No. 1 *b*. Is a portion of the middle of the femur of a Mastodon.

No. 2 *a*. Is a portion of the lower jaw of the left side of a Rhinoceros, containing a perfect tooth, which has been accidentally divided. It has belonged to an animal now extinct, and of larger size than the *Rhinoceros unicornis* of this country. The form of the tooth is different from that found by Mr. Crawfurd, but as the characters vary, from wearing, with the age of the animal, it is no easy matter to determine whether or not it belongs to a different species. It resembles very closely in form the *Rhinoceros eriques* of the 'Ossemens Fossiles' of Cuvier.

Nos. 3 *a*, *b*, and *c* are vertebræ from different parts of the spinal column of *Crocodileæ*. Some of the bones carried to Europe were found to belong to the *Leptorhynchus* of the Ganges, or a species very nearly allied.

Nos. 4 *a*, *b*, *c*, and *e* are osseous fragments of two large genera of Turtle, the *Emys* and *Trionyx*. The remains of these animals bear a large proportion to the other bones.

There are several specimens, comprising the greater part of the collection, to which no names have been attempted to be given. Some of them are well marked, and the individuals to which they belonged might be hazarded with a tolerable degree of confidence; but when the evidence fell short of certainty, it appeared better to present the bones without attempting to name them than run the risk of giving misnomers and misleading others.

A correspondence has been discovered between a specimen from the Himalayahs and those of the *Trionyx* or *Emys* from Ava; there can be little doubt that when we have an opportunity of making a comparison of the fossil bones from both places further coincidences will be brought to light.

XXV. NOTES ON FOSSIL REMAINS FOUND IN THE VALLEY OF THE INDUS BELOW ATTOCK, AND AT JUBBULPOOR.[1]

I HAVE examined the fossils from Attock presented to Dr. Oldham by Lieutenants Garnett and Trotter. They are very interesting. Among them I have found the following:—

1. A species of *Dinotherium*, probably new. Of this there are two undoubted molars. The first is apparently the penultimate or first premolar, upper jaw, right side. At least, this is inferred from its form and an obscure disc of pressure on the posterior side, and from there being no disc of pressure in front. The tooth consists of a longitudinal ridge on the outer side, the enamel edge of which is rounded off, but not much worn. It is convex in its antero-posterior direction, and separated by a broad valley from two inner mastoid points. These points are sub-pyramidal, the apex of the anterior one being slightly pitted by wear. There are no transverse ridges. In the first penultimate milk molar of Kaup (Plate I.) the anterior ridge is bifid; in this it is quite entire. The tooth also shows very large fangs.

	European form	Attock form
Antero-posterior diameter, outer edge	2·X	2·95
Do. do. inner „	1·7	2·1
Transverse do.	2·1	2·8

The Indian fossil is smaller than the European. It differs also in the following respects. The surface of the crown is free from the vertical groove; the anterior talon is much more salient; the crenulated bourrelet is limited to the ends and there is a bridge between the inner points; whereas in the European fossil the crenulated bourrelet runs all round.

The second specimen, judging from its square proportions, is the antepenultimate true molar, upper jaw, right side. The two anterior ridges are well worn; the last ridge is barely touched; only the crenatures are gone. In form it is very like the tooth of the European species. The last ridge is somewhat concave and crescentic across, as compared

[1] These fragmentary notes are extracted from Dr. Falconer's note-books.—[ED.]

with one of Kaup's casts (marked *d.* 9 and 14 *f*). The measurements are:—

	European fossil	Indian fossil
Extreme length	3·	2·7
Extreme width of crown, first ridge	2·7	2·4

John Hunter's original specimen (Cat. Coll. Surg. Eng. No. 800), called 'the third deciduous upper molar, right side,' has these dimensions: extreme length, 2·7; width, 2·.

The most prominent distinctive character is the uniform convexity of the outer surface of the first true molar.

The species would probably be too small for the *Dinotherium Perimense.*

2. *Tapirus Pentapotamiæ* (Falc.). This species is also new to the Indian fossil fauna. One specimen is a tooth which is probably the right penultimate true molar upper jaw. Both ridges are slightly worn, and there is a disc of pressure in front and behind.

	Inches
Length of crown	0·85
Width at base in front	0·8
Do. behind	0·84

The tooth corresponds with the penultimate true molar upper jaw, right side, of the American Tapir (*Tapirus Americanus*), but it is a trifle smaller.

	Attock	Malay	American
Length	0·82	1·1	·9
Width in front	0·8	1·2	·95
Ditto behind	0·8	1·1	·8

The two smaller teeth would agree with the form of the first premolar. They are distinctly bi-cuspid, as in the Tapirs. The definition of the cusp is much more pronounced in the fossil, and the form of the tooth more triangular.

3. *Sus pusillus* (Falc.). The specimen is a fragment of the right ramus of a lower jaw of a small swine animal. It consists of the upper part of the ramus and the base of the coronoid, and it contains the posterior two-thirds of the last molar *in situ*; the tooth is three-barrelled and the crown has the rough warty swine character. The enamel is very thick; the anterior barrel is broken off.

	Inches
Length of crown from alveolus	0·65
Width of middle at base	0·3
Height of enamel crown	0·2

The talon is nearly as large as the middle barrel. The jaw is clearly of a full-sized animal, and therefore it belongs

to a small species of a genus undetermined. It is not *Hippohyus*. I have named it provisionally *Sus pusillus*.

4. *Merycopotamus nanus*. The difference in the dimensions of the last molar from Attock is so great from those of *Merycopotamus dissimilis* that the former must have been a distinct species (See *antea*, p. 138).

	Merycop. dissimilis	Merycop. of Attock
Length of last molar	1·1	0·75
Width of do. in front	1·2	0·8

5. *Amphicyon*. The specimen is the tubercular tooth of a large carnivorous animal, as large as the Polar Bear and allied to the *Amphicyon*, which occurs in the European miocene strata along with *Dinotherium*.

6. *Antoletherium*.[1] Among the fossils discovered by Lieut. Garnett, near Attock, is a portion of the lower jaw of a tapiroid animal containing what appear to be the last premolar and the first and second true molars. Of this specimen I have received an excellent drawing executed by Col. Baker, who regarded the species as allied to Tapir. (Plate XXXIV. figs. 1 and 2.) The teeth certainly differ generically from those of *Dinotherium* in the massive connecting bridge between the two ridges, speedily running them into one confluent disc. The bend of the first ridge is very tapiroid. The specimen appears to me to be of an undescribed genus for which the provisional name *Antoletherium* (*ἀντολὴ* the east, and *θηρίον*) would be appropriate.

[Col. Baker's drawing was transmitted by Dr. Falconer to Professor Owen, who replied on Nov. 19, 1856, as follows.—Ed.] :

'In the sketch, which I now return, B is more worn than A, and A than C. B may therefore be m. 1, and C, p. 4, or the last premolar, A being the second true molar, m. 2. From the wearing it would seem as if A and B had had more connecting matter between the two ridges than C has, and that C was a more simple or decidedly two-ridged tooth. The bend of the first ridge appears to be tapiroid, or lophiodontoid.'

[Among Dr. Falconer's notes there is a further memorandum respecting the same specimen, dated 9th November, 1857, which is appended. Dr. Henry Walker had formerly been a colleague of Dr. Falconer's as Professor in

[1] It does not appear from Dr. Falconer's notes that he had seen the specimen, which is here described from a drawing made by Col. Baker.—[Ed.]

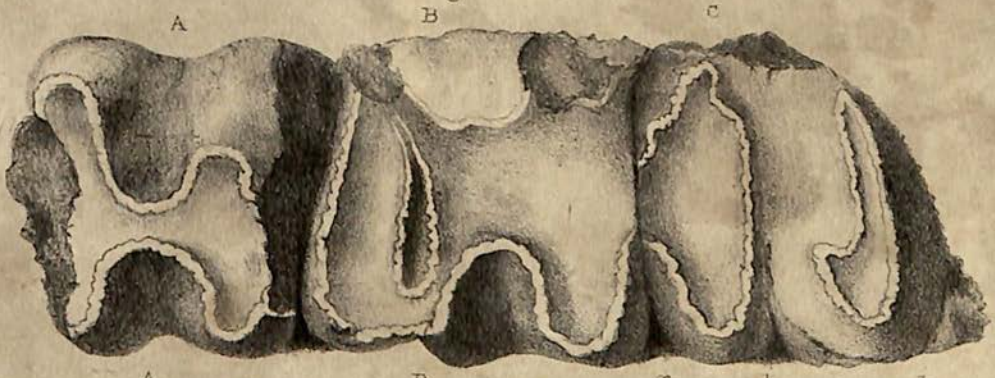
DESCRIPTION OF PLATE XXXIV.

Figs. 1 and 2. Show, in plan and profile, the teeth from Attock of the Tapiroid animal described at page 416 under the designation of *Antoletherium*. The figures have been copied from the pencil drawings by Col. Baker referred to in the text, and are three-fourths of the natural size.

Figs. 3, 4, and 5. Three different views of the fossil vertebra from Jubbulpoor, described at page 418, one-third of the natural size.

Figs. 6 and 7. Two views, in plan and profile, of the antepenultimate upper left molar of *Mastodon* (*Trilophodon*) *Pandionis*. The specimen thus identified in Dr. Falconer's handwriting was found in his private collection, and has been deposited in the Palæontological Gallery of the British Museum. The drawing is about two-fifths of the natural size. (See page 124.)

Fig. 1.



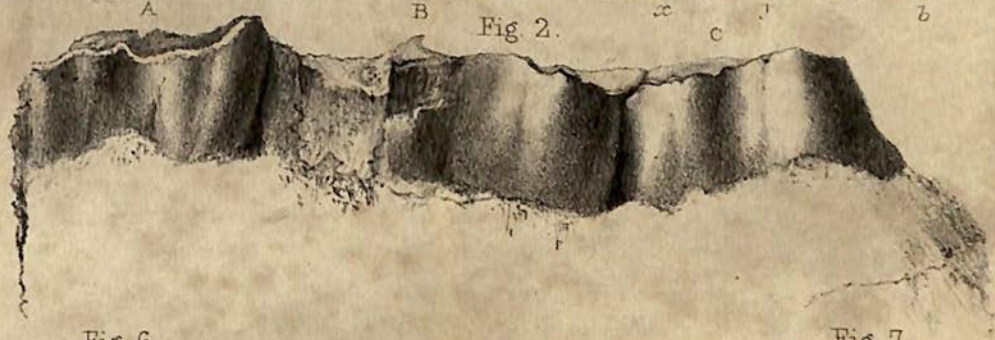


Fig. 2.

Fig. 6.

Fig. 7.

Fig. 3.

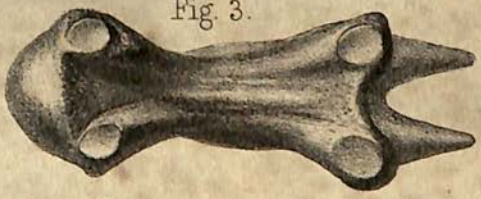


Fig. 4.

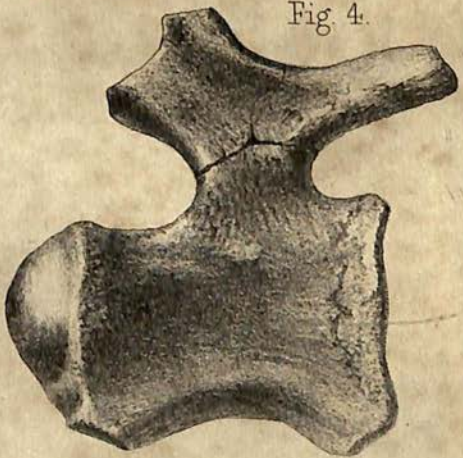


Fig. 5.

J. Dinkel lith. 1, 2. Antoletherium. 3, 4, 5, Fossil Vertebra from Jubbulpoor. W. West imp.
6, 7. Mastodon Pandionis.

the Medical College of Calcutta, and had assisted him in editing the Catalogue of Fossils in the Museum of the Asiatic Society. He died in 1857.—Ed.]

'Found among Walker's papers two rough sketches—side and plan. The one is evidently of a form closely allied to *Dinotherium*. Oldham's specimens comprise two teeth, both apparently three-ridged, considered by Walker between *Dinotherium* and *Diprotodon*, the other regarded by him as of *Mastodon latidens*, but evidently the same specimen as Baker's drawing of the Attock tapiroid form from Lieut. Garnett. Walker's sketch throws a new light on it. The tooth (A), as in Baker's drawing, shows two ridges, both worn and connected by means of a bridge. The middle molar (B) shows three ridges, all much worn and confluent into a common disc; the third molar (C) shows only a single ridge, slightly worn, the rest of it being apparently broken off. From Baker's drawing I had formed the impression that the last ridge of the middle molar (B) formed part of the tooth (C). But Walker's side-sketch draws the line of demarcation very marked. It is very puzzling to say which is the anterior molar and which the posterior. B is the most worn and therefore the oldest tooth, and C is much less worn than A, and therefore younger than it in appearance, i.e. later. The distal (free) ridge of A appears to be more worn and to be of wider transverse diameter than the prominent ridge (i.e. that nearest the middle molar). Hence A is inferred to be p.m. 4, or the last premolar; B to be the first true molar, m. 1, three-ridged; and C the anterior ridge of the m. 2, or the penultimate true molar. This is the reverse of the view first taken by me from Baker's drawing, and from that which was suggested to Owen by it.'

[Dr. Falconer subsequently wrote to Col. Baker in Calcutta for further information respecting the specimen, who on Jan. 13, 1858, replied to the following effect.—Ed.]

'Your first impressions regarding the subdivision of the fossil teeth, represented in my sketch, coincides with my own.

Tooth B, in my opinion, consists of two ridges and terminates at *x*.

Tooth C extends from *x* to *b''*. The mark at *y*, in Walker's sketch, indicates his opinion that there existed on that line a division between two teeth. I am quite certain that there does not exist any external visible mark more distinct than what is shown in my sketch.'

Memorandum of two remarkable Vertebræ, sent by Dr. Oldham from Jubbulpoor—Spilsbury's Bed.

29th August, 1862.

The larger vertebra consists of a compressed body, very considerably compressed sidewise, and contracted in diameter between the articular surfaces, both in the vertical and transverse direction. The anterior articulation is elliptical vertically in its outline, and the cup as deep as in the *Crocodilia*; the posterior articulating surface is of a corresponding *reversed form*, i.e. very convex, flattened laterally, the greatest convexity being towards the middle or axis. The inferior surface of the body at either end bears, immediately behind the rim of the cup in front, and in front of the ball behind, *a pair* of surfaces for the articulation of a *chevron* bone, i.e. each *chevron* has been articulated to two adjoining vertebræ.

The spinous process, which is broken off, is flattened and of considerable size towards the base; it is given off from the body backwards at an angle of about 45°. Between it and the body there is a semicircular niche about 1·2 inch deep. From the anterior part or base of the spinous process two articular apophyses are given off nearly horizontally, or inclined upwards at a small angle, and diverge, but the divergence is small. The articular surfaces are on the axial side (inside).

It would appear that the next anterior vertebra passed its spinous process between these articular surfaces; but no marks of such articulation are seen in the spinous process of the vertebra.

Dimensions.

	Inches
Extreme length of body	5·4
Height in middle to hollow between spinous and articulating apophysis	4·9
Height of anterior concave end	3·4
Width of do.	2·4
Length of body from rim to base of ball	4·1
Height at base of ball behind	3·4
Transverse diameter of do.	2·3
Height of body where constricted behind	2·8
Greatest constriction of do.	1·3
Length of articular process	2·2
Do. from base of spinous process to tip of do.	4·
Length of lamina, right side	1·8
Vertical diameter of spinous process	1·9
Transverse diameter of do.	0·8

Vertebral canal small and constricted; not a trace of a suture remaining (See Plate XXXIV. figs. 3, 4, and 5).

The other vertebra, No. 2, is shorter and less perfect. The spinous process is broken off at its base, and the articular

processes, if any, are gone. The body is shorter and less constricted; there are the same ball and socket ends, but they are not so deep; there are also the two pairs of articular surfaces for chevron bones.

Dimensions.

	Inches
Length of body	4·3
Do. between articular ends	3·1
Vertical height of body in middle	2·7
Constriction of do.	1·55

This vertebra is more square in form than the other, and is much shorter.

XXVI. NOTE ON AN EXTRAORDINARY VARIETY OF ELASTIC SANDSTONE.[1]

BY H. FALCONER, M.D.

I HAVE lately had sent to me to look at, by Captain McNaghten, of Kurnal, a specimen of rock which has surprised me beyond measure. It is a slab of sandstone 14 inches long by 5¼ wide, and two inches thick, and looks like a long brick. It exactly in appearance resembles the building sandstone used at Agra. *It is flexible and elastic in every direction!* If you place it flat on a table, and press the hand on one end and raise the other, you can bend it to a certain extent, and see the undulations moving along to the fixed end. If you seize it by both ends, one in each hand, and make an action as if you intended breaking it, you can see and feel it hard like a piece of whalebone, but of course in an infinitely smaller degree, and the undulations are observed propagated from end to end. If you tap it on the side with the finger as you would a mussak of water, it yields pretty much in the same fashion, propagates an undulation, and instantly recovers its form. If you press it at the sides it gets narrower, and if you pull at the ends it elongates! but it always recovers its original form. Is there any account on record of so extraordinary a sandstone? Should there not, I may send you some notes about it. It is not known where the specimen came from.

H. F.

[1] This note was communicated to the Secretary of the Asiatic Society of Bengal in April 1837, and was published in the 'Journal' of the Society, vol. vi. p. 240.—[ED.]

XXVII. A DESCRIPTION OF THE PLATES IN THE FAUNA ANTIQUA SIVALENSIS.

(Compiled by the EDITOR, from Notes and Memoranda by H. FALCONER, M.D.)

[THIS description has been mainly compiled from the following sources:—1. Memoranda in Dr. Falconer's note-books and papers; 2. References to certain of the figures in his published memoirs on Elephant, Mastodon, &c.; 3. References to other figures in his correspondence with scientific friends; and 4. Labels in his handwriting on the specimens figured which are now in the British Museum. Although the figures are drawn to scale, the actual measurements have, as far as practicable, been introduced into the description of each figure. It has been thought that by their means, the value of the descriptions would be increased to those who have not an opportunity of consulting the Plates, and that even to those who possess the Plates the comparison of specimens would be facilitated. The measurements are given in English inches, and in tenths of an inch. The letters B.M. indicate that the specimen referred to is in the British Museum.—ED.]

Plates I., II., and III. are intended to represent, by careful copies of nature, the modifications in structure and form exhibited by the molar teeth of the *Proboscidea*. They show in vertical sections a series of gradations, commencing with *Dinotherium* and *Mastodon Ohioticus* at one extremity, and running through the other species to *Elephas primigenius*, in which the greatest deviation from the ordinary form of a grinding tooth is met with.

PLATE I.

Fig. 1.—*Elephas primigenius*, or the true Mammoth: longitudinal and vertical section of last upper molar, left side, from an English specimen found near Kingsland, and formerly in the Museum of the Geological Society. Shows the 'ridge formula' and the form and relative proportions of the alternate layers of ivory. The section closely resembles that of the corresponding tooth of the Indian Elephant, but the ivory segments are even thinner, more vertical, and more approximated. The disposition of the plates presents the extreme degree of 'pectination' seen in the molars of any known species of elephant.—B.M. (Reproduced in Plate V. fig. 3.)

Length, 11 in. No. of plates, 21. Depth of enamel at tenth plate, 6·2 in. Length of space to 10 plates, 4½ in.

Fig. 2 *a*.—*Elephas Indicus*. Vertical section of an upper penultimate molar of the existing Indian Elephant. It is composed of seventeen ridges, with a reduced talon splent behind, the anterior

talon being confluent with the first ridge. The anterior eight plates are inclined forwards, and by the process of wear they are ground down, so that the front part of the tooth is truncated obliquely before the posterior lamellæ have come into use. The plates are very thin and vertical, and the enamel is thin. The gradual attenuation of the plates, successively exhibited from *E. insignis* to *E. Hysudricus*, is here carried to excess, eighteen being comprised within the space occupied by about nine in the equivalent tooth of the African species. The pectinated arrangement contrasts strangely with the chevron-formed ridges of *E. insignis* and the cuneiform plates of *E. planifrons*. The mass of ivory at the base of the tooth is much thinner than in the corresponding molar of *E. Hysudricus*. (Reproduced in Plate V. fig. 2.)

Length of crown, 8·2 in. Space occupied by 10 plates, 4½ in. Height at tenth plate, 6 in.

Fig. 2 *b*.—*Elephas Indicus*. Vertical section of unusually large specimen of last lower molar of an Indian Elephant from Assam, in India House collection. The entire length of the crown is about fifteen inches, and it includes as many as twenty-seven ridges, of which the anterior thirteen are more or less abraded. The first five or six ridges incline a little forwards, while the posterior ridges incline so much in an opposite direction, that the hindermost are nearly horizontal, producing the flabelliform character that so readily distinguishes in most instances the last from the penultimate lower molar. The same disposition and proportions of the dental substances are observed as in the upper grinder.

Fig. 3 *a*.—*Elephas Hysudricus*, from the Sewalik hills. Vertical section of penultimate upper molar, left side. The tooth is in the middle stage of wear, eleven of the thirteen plates of which it is composed having been in use, and the two anterior ridges being worn out. The same vertical disposition of ivory, enamel, and cement is presented as in the African Elephant, but the plates are thinner and more vertical; the layer of enamel is proportionally thicker; and the interspaces occupied by the cement are wider in general than the ivory plates.—B.M. (Reproduced in Plate V. fig. 1.)

Length, 7·7 in. Length of 10 plates, 5·75 in.

Fig. 3 *b*.—*Elephas Hysudricus*. Vertical section of portion of last molar of lower jaw, comprising about fifteen plates. The same general character, in the disposition and relative proportion of the ivory, enamel, and cement are exhibited as in the upper molar, bearing in mind that the latter is a younger and consequently smaller tooth. The layer of enamel, however, is thinner than in the upper molar. The ivory segments curve back near their base, and the apices of the posterior plates lean towards the front of the tooth, a disposition still more marked in the existing Indian Elephant. The dark shade below the ivory indicates a core of sandstone, occupying the place of the unossified part of the pulp nucleus, and of the undeveloped fangs.—B.M.

Plate II.

Fig. 4 *a*.—*Elephas Africanus*. Vertical section of a penultimate grinder, upper jaw, of the existing African Elephant, in the possession of Mr. C. Stokes. It is composed of nine principal divisions and a subordinate talon ridge, the four anterior of which are partly worn, the rest being entire. The ivory segments consist of long narrow wedge-shaped plates,

the height of which is many times greater than the width of their base. The interspaces are deep and filled up with copious cement. The enamel and common basal mass of ivory are much less than in either *E. insignis* or *E. planifrons*, the latter being only sufficient to establish a common connection between the bases of the segments, and a foundation for the offset of the fangs, which are numerous. (Reproduced in Pl. IV. fig. 3.)

Length, 8·7 in.

Fig. 4 *b*.—*Elephas Africanus*. Vertical section of penultimate molar of lower jaw, belonging to Mr. C. Stokes. It is composed of nine cuneiform plates. This tooth had been a long time in use, all the plates, except the last being affected by wear. The anterior part of the crown has been ground down to nearly one-third of its original height, so that the enamel divisions between the two anterior ivory plates have disappeared, and the latter are confluent into a common mass. The section exhibits the same kind of wedge-shaped ivory plates, a similar amount of cement in the interspaces, and an analogous thickness of enamel as in *E. planifrons*, fig. 5 *b*.

Length, 7·2 in.

Fig. 5 *a*.—*Elephas planifrons*, from the Sewalik hills. Vertical section of penultimate upper molar, with nine ridges, the three anterior of which alone have been in use, the two first being worn down to a single disc of ivory. The ridges are seen to be much more elongated vertically than in *E. insignis* (fig. 6 *a*), but to be considerably less so than in the African Elephant. From the latter it also differs in the enormous quantity of cement, filling up the valleys and enveloping the ridges, and in the much greater thickness of the folded plates of enamel. The enamel is reflected over the ridges of ivory, and down into the hollows zig-zag wise, exactly as in *E. insignis*.—B.M. (Reproduced in Plate IV. fig. 2.)

Length, 8·7 in.

Fig. 5 *b*.—*Elephas planifrons*. Vertical section of portion of last molar of lower jaw, with nine ridges, and presenting the same general characters as fig. 5 *a*. The lower tooth, however, had been longer in use, and all the ridges are more or less worn, except the two last.—B.M.

Fig. 6 *a*.—*Elephas insignis*, from the Sewalik hills. Vertical section of last upper molar. The four anterior ridges are affected by wear; the six posterior ridges are entire, the fangs are fully developed, and their mode of implantation in the jaw is distinctly shown. The white mass in the centre represents the body of ivory, which is projected upwards in ten angular lobes, terminating in a sharp edge. The height of these lobes does not much exceed the width of their base, and closely applied over them is a thick layer of enamel reflected up and down in a continuous zig-zag plate. The interspaces of the five posterior ridges of enamel are completely filled up by a mass of cement much exceeding the enamel in thickness (*vide* Plate VI. fig. 7). This is the best illustration of the intermediate type of a proboscidean molar tooth, from which those of the other species diverge in opposite directions. It belongs to the *Mastodon Elephantoïdes* of Clift. The dark granulated shade below the portion of the ivory nucleus sustaining the five posterior ridges indicates the hollow of their common fang, which in the fossil is occupied by a core of sandstone.—B.M. (Reproduced in Pl. IV. fig. 1.)

Length of tooth, 10·3 in.

Fig. 6 *b*.—*Elephas insignis*. Vertical section of anterior portion of adult tooth of lower jaw. The two front ridges only have been touched by wear. The ivory, enamel, and cement present the same characters as in the upper molar, but the common curve of the crown is slightly concave instead of convex. The posterior part of the basal portion of the pulp nucleus has not completed the stage of calcification, its place being occupied by a nest of calcareous crystals. The figure also shows two ridges of the preceding molar, with their common fang implanted in the lower jaw.—B.M.

Plate III.

Fig. 7 *a*.—*Elephas Ganesa*, a fossil Indian species. Vertical section of last upper molar. The crown consists of ten principal ridges, with a subordinate talon ridge in front and behind. The anterior seven ridges have their summits worn. A small portion is broken off at the anterior end. The disposition and relative proportions of the ivory, enamel, and cement bear the closest resemblance to those of the corresponding tooth of *E. insignis*, and the number of ridges agrees. In fact, there are no good characters by which the teeth of these two species can be satisfactorily distinguished, although the crania are so remarkably different.—B.M. (Reproduced in Plate VI. fig. 1.)

Length of tooth, 9·25 in.

Fig. 7 *b*.—*Elephas Ganesa*. Vertical section of posterior molar of lower jaw. A small portion of the anterior end of the crown has been broken off, but the presence of the anterior fang proves that the section includes the whole length of the tooth, except the first ridge, the posterior end being entire. It appears to have consisted of eight principal ridges, with a talon ridge behind, and a subordinate ridge in front. Five of the ridges have been in use, the anterior two being worn down close to the common base of ivory; the three last ridges are entire. It bears a close resemblance to the corresponding inferior tooth of *E. insignis* in the form of the ridges, thickness of enamel, and proportion of cement.—B.M.

Fig. 8.—*Mastodon latidens* (Clift). Vertical section of two last molars of upper jaw. The specimen of which the section was made was formerly in the collection of the Geological Society, and is figured in Clift's memoir (Plate XXXVII. fig. 1). The last tooth shows five principal ridges with a posterior talon ridge and a subordinate ridge in front. The ridges are transverse and divided by a longitudinal cleft into two pairs of principal points without intermediate mammillæ in the hollows. The enamel is very thick and the cement is reduced to a thin layer, only observable in the bottom of the hollows. The ivory lobes resemble those of *E. Ganesa*, but are less elevated, with a broader base. The anterior tooth had been a long time in use, and the ridges are nearly all worn out; they were four in number. *Mastodon latidens* is the form most nearly allied to *E. Cliftii*, and, through that species, to the true Elephants.—B.M. (Reproduced in Plate VI. fig. 2.)

Length of last tooth, 5·5 in.

Fig. 9.—*Mastodon Ohioticus*. Vertical section of last upper molar. It consists of four principal ridges and a small talon lobe. The ridges are transverse, terminating in a trenchant edge; the ivory segments are in regular angular lobes; the layer of enamel is of uniform thickness,

and the hollows between the ridges are very wide and open, being almost rounded at the bottom. There is only an exceedingly thin crust of cement, continued over the fangs in greater thickness. The common plane of the grinding ridges of the crown is nearly horizontal. *M. Ohioticus* constitutes the terminal link in the chain, and through *Dinotherium* establishes a passage into the ordinary Pachydermata.—B.M. (Reproduced in Plate VII. fig. 2.)

Fig. 10 *a*.—*Mastodon Sivalensis*, from the Sewalik hills. Vertical section of last upper molar. The ridges are more complex in their composition than in *M. latidens*. The crown is bisected by a longitudinal furrow, each division of the ridge being composed of a pair of contiguous conical mammillæ placed more or less alternately. The hollows are in consequence interrupted. There are five principal ridges, with a subordinate ridge in front, and a talon ridge behind. Eight divisions of the ivory may be counted in the figure, the smaller segments arising from the direction in which the section has been made through the alternate mammillæ. The ridges are approximated, and the enamel bears a large proportion to the conical lobe of ivory which it invests. The cement is entirely wanting, except in the bottom of the clefts.—B.M. (Reproduced in Plate VII. fig. 1.)

Length of tooth, 7 in.

Fig. 10 *b*.—*Mastodon Sivalensis*. Vertical section of greater part of last lower molar. The tooth differs from the corresponding upper molar only in being complicated with an additional ridge.—B.M.

Fig. 11.—*Dinotherium Indicum* (Falc.), from Perim Island. Vertical section of posterior ridge and talon of the penultimate lower molar, left side. The internal structure exhibits the same agreement with that of the European Dinotherium, as is indicated by the external form. The only perceptible difference is, that the angle formed by the ridge of the ivory is more acute, and the enamel thicker in the Indian species. The centre is occupied by a rhomboidal core of arenaceous matrix marking the form of the unossified pulp nucleus. This tooth is described and figured in Dr. Falconer's Memoir on Perim Island Fossils (*Vide* page 396, and Plate VI. fig. 3.)

Fig. 12.—*Dinotherium giganteum* (Kaup), from Eppelsheim. Vertical section of entire penultimate lower molar, consisting of two transverse crenulated ridges, and a talon ridge, while in the equivalent molar of *Mastodon Ohioticus* there are three principal ridges. Corresponding to the smaller number of divisions the ridges are more widely separated, less elevated, and broader at their base, while the interspaces are also wider and more open than in the North American Mastodon. The layer of enamel is of similar thickness, and there is no appreciable crust of cement. The correspondence is followed out in the form of the subordinate heel ridge. *D. Indicum*, however, is the species most nearly allied to *M. Ohioticus*.—B.M. (Reproduced in Plate VII. fig. 3.)

Plate IV.

Elephas Hysudricus. (Falc. and Caut.), from the Sewalik hills. Front view of skull, one-fifth nat. size. This fine specimen was purchased from Conductor Dawe.—B.M.

Length of the cranium from the protuberances of the occipital to the broken tip of left incisive, 45 in. Length from broken occipital condyles to anterior border of

alveolus, 28· in. Vertical height of head, from broken condyles to the pyramidal bulge of sinciput, 26· in. Vertical height from surface of occipital to the tip of the nasals, 27·75 in. Extreme width of the head restored on left side, 38·5 in. Width at narrowest part of forehead between zygomatic fossæ, 10·5 in. Width of naso-maxillary fissure, 18·5 in. Depth from tip of nasals to anterior margin of naso-maxillary fissure, 3·5 in. Depth of rami of naso-maxillary fissure, 4· in. Width between middle of the orbits, mesial, 26· in. Greatest width of zygomatic fossa, 12· in. Depth from hollow of frontal to condyles, 20· in. Depth from posterior border alveolus to margin of naso-maxillary fissure, 21·5 in. Length of alveolus of last grinder, 10·5 in. Depth of hollow of frontal below mesial plane, 4·5 in. Extreme width of alveolus, 4·75 in. Width of incisive sheath in front of the alveolus, 18·5 in. Transverse diameter of the left tusk, 7·5 in. Antero-post. of the left tusk, 7·75 in. Depth below mesial plane of the occipital hollow, 8·5 in. Width of bottom of occipital hollow, 5·75 in. Depth of posterior bulge of the cranium from the occipital bone to surface of zygomatic fossa, 15·5 in. Least width at back part of cranium behind the alveoli, 8·5 in. Depth from posterior broken surface of condyle to the posterior border of the alveolus, 19· in. Depth of infra-orbital foramen, 2·5 in. Transverse diameter of foramen, 1·75 in. Length of infra-orbital canal, 6· in. Depth of the left orbit, 6·75 in. From anterior margin auditory foramen to anterior border of the orbit, 20· in. Vertical diameter auditory foramen, 1·5 in. Depth of the fossa between incisive sheaths at the top of it, 6·5 in. Width across fossa, 3· in. Depth of the naso-maxillary vault, 12· in. Depth of skull from posterior end of socket to the orbit, 22·5 in.

PLATE V.

Figs. 1, 2, 3, and 4.—*Elephas Hysudricus.* Four different views of same skull as in Plate IV., $\frac{1}{8}$ nat. size.—B.M.

PLATE VI.

Figs. 1 and 2.—*Elephas Hysudricus.* Perfect small head from the Geol. Soc. Museum, with the second and third milk molars, and first true molar in germ. The second milk molar on left side is much worn. The infra-orbital hole is very large. The tusks are oval on section, as shown in fig. 3 of another animal of same age. The palatal bones are divergent in front. The tusks are also a little divergent, and are very near in size those of the young Indian Elephant, but are narrower in front and more convex. The palate is not figured.—B.M.

Extreme length from occipital crest to broken incisor, 23·3 in. Length from occiput to tip of nasals, 13·8 in. Width of nasal opening, 7·1 in. Depth of nas. op. at sides, 2·8 in. From lower end of nasal opening to tip of incisives, 9·5 in. Semi-diameter from tip of nasals to left orbit, 6·3 in. Width of brow, 12·6 in. Width at contraction of incisive sheaths, 5·6 in. Extreme length of orbit, 3·5 in. Width at tips of incisive sheaths, 5·6 in. Vertical diameter of left tusk, 1·8 in. Transverse diameter of left tusk, 1·5 in. From outer margin of orbit to occiput, 16·8. in. Width of brow at temporal contraction, 6· in. Length of second milk molar, 2·1 in. Width of second milk molar behind, 1·6 in. Number of plates, 5. Length of third milk molar, 4·3 in. Width in front, 2·1 in. No. of ridges 7, with a front and heel ridge. Interval between second milk molars in front, 1·9 in. Interval between third, 2·2 in. From niche of palate to commencement of diasteme, 5·3 in. Length of diastemal ridges to tip, 6·3 in. Interval between ridges at base, 1·4 in. Expansion at tip, 2·9 in.

Fig. 3.—*Elephas Hysudricus*, under surface of young skull. This specimen agrees in age and characters with that shown in figs. 1 and 2, except that the third milk molar has 8 principal ridges, with a front and back heel, instead of 7 as in the other.—B.M.

Length of second milk molar, 2·2 in. Width of second milk molar, 1·6 in. No. of plates about 5. Length of third milk molar, 4·3 in. Width, 2· in. Interval between second teeth, 1·2 in. Between third, 2·1 in.[1]

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[1] Notes by Dr. Falconer of other specimens of *E. Hysudricus*, not figured.

1. A small head with second and third milk molars, of exactly the same age as

Figs 4, 5, and 6.—*Elephas planifrons* (Falc. and Caut.), from the Sewalik hills. Portion of cranium with palate containing premolar, third milk, and first or antepenultimate true molar. The left premolar consists of three principal ridges and an indistinct front and back ridge. Their direction is so oblique that they point nearly fore and aft. This little tooth is nearly globular in form and is quite untouched by wear. The crown is composed of a number of tubercles irregularly huddled together, somewhat in a botryoidal manner, and presenting no distinct indication of transverse ridges. A hollow filled with matrix is seen on the right side, where the corresponding tooth had dropped out. The third milk molar is very broad, all the six ridges worn, enamel thick. The first true molar is entirely in germ. —B.M.

Length of premolar, 1·2 in. Width, 1·1 in. Height of crown, ·8 in. Length of third milk molar, 4· in. Width, 2·4 in. Number of ridges 6, with a heel and front ridge. Length of first true molar, 5·5 in. Width, 2·7 in. Greatest height at fourth ridge, 3· in. Number of plates 7, with front and back ridges. Interval between third milk molars in front, 2·3 in. Ditto at niche of palate behind, 2·8 in.[1]

Fig. 7.—*Elephas insignis*. Section of molar showing laminated character of cement filling up the valleys. In some sections as many

the small head, Plate vi. fig. 3, and Plate vii. fig. 1, if anything younger, as only the first ridge is touched by wear. Shows the plates of the second milk molar better than any other.

Length of second left milk molar, 2·5 in.; width, 1·6 in.; has 5 distinct ridges and a heel. Length of third milk molar, 4·1 in.; width, 2· in.; has 7 main ridges with a large front ridge and large heel, or 9 good plates. Interval between teeth in front, 1·6 in.; between last teeth behind, 2·1 in.

2. Another imperfect head of young *E. Hysudricus*, of same age as fig. 1 of Plate vi. Has second and third milk molars in use and first true molar in germ. The second milk molar is well worn, the third has the five first plates worn.

Length of second milk molar, 2·3 in.; width, 1·7 in.; number of plates 5, and a heel. Length of third milk molar, 4·6 in.; width, 2·3 in.; number of plates 8, with front and heel plates in addition. Height of sixth plate, 2·6 in.

3. Fragment of a very large cranium comparatively as regards the age of the teeth. Contains the third milk molar and first true molar. The third milk molar is well worn, with 7 ridges and a back and front ridge; the two front ridges worn. The tooth is very broad, broader even than the third milk molar of *E. planifrons* (Plate vi. figs. 4 and 5); the enamel is thin, and finely crimped. The first true molar is equally remarkable in being broad and short and in having few ridges. The first four ridges are touched by wear. It is proved to be *E. Hysudricus* by the great size of the nasal opening, and the downward direction of the rami.

Length of third milk molar, left side, 3·8 in.; width, 2·6 in. Length of first true molar, 6· in.; width, 2·6 in.; number of plates 8, with a large front ridge and a very large heel. Interval between the front teeth on either side, 1·6 in.; behind at the niche, 2·7 in. Depth of cranium from posterior surface of molar to brow between the orbits, 13·8 in. Width of brow between middle of orbits, 13·6 in. Width of naso-maxillary opening, 9·4 in. Width of muzzle at suborbital foramen, 10· in.

[1] Another valuable specimen of palate of *E. planifrons* is of same age as that in Pl. vi. figs. 4, 5, and 6, but is a little further advanced and belonged to a larger animal. The first true molar is an inch longer and is much broader and higher. The points of the plates are few, being about 6 to the fifth and sixth plates. The apices of the plates are somewhat incurved or bent forward. The specimen consists of the back portion of left side of palate. The last ridge of the third milk molar is in front.

Length of first true molar, 6·5 in.; greatest width, 3·4 in.; height at fourth ridge, 3·5 in.; has 7 principal ridges with front and back ridge.

as eleven distinct strata of this substance may be counted. The section is a portion of the tooth represented in Plate II. fig. 6 *a*, comprising the sixth and seventh ridges, and drawn to natural size.

Plate VII.

Fig. 1.—*Elephas Hysudricus*. Fragment of upper jaw containing second and third milk molars. Age of individual about same as in Pl. VI. fig. 3.—B.M.

Figs. 2 and 2 *a*.—*Elephas Hysudricus*. Fourth tooth, or first true molar, upper jaw, right side; 12 plates. Vertical Section in B.M.

Figs. 3 and 3 *a*.—*Elephas Hysudricus*. Fragment of upper jaw containing fifth tooth or penultimate true molar, 13 plates. Vertical section in B.M.

Figs. 4 and 4 *a*.—*Elephas Indicus* (erroneously designated *E. Hysudricus* in Plate). Last grinder of upper jaw. The anterior plates are inclined forwards, and by the process of wear they are ground down, so that the front part of the tooth is truncated obliquely, before the posterior lamellæ have come into use. The plane of detrition makes a large angle with the unworn plane of the crown, and slopes from the inside outwards. On the worn surface the digitated summits of the anterior ridges are found ground down into circular rings of enamel enclosing a pit of ivory.—B.M.

Fig 5.—*Elephas Hysudricus*. Fragment of lower jaw, left side, with second milk molar, vertically divided, and showing 7 or 8 plates. Specimen shows also remains of alveolus of first tooth.—B.M.

Fig. 6.—*Elephas Hysudricus*. Inferred to be lower jaw ? left side ? with second milk molar. Large variety, with 9 plates.—B.M.

Length, 3·4 in. Width in front, 1·1 in. Width behind, 1·8 in.

Figs. 7 and 7 *a*.—*Elephas Hysudricus*. Fragment of lower jaw, left side, with second milk molar, showing 7 or 8 plates.—B.M.

Length, 3·1 in. Width, 1·5 in.

Fig. 8.—*Elephas Hysudricus*. Lower jaw, left side, with third milk molar.—B.M.

Length, 5·5 in. Width, 2·2 in. No. of plates, 9.

Fig. 9.—*Elephas Hysudricus*. Fragment of lower jaw, with third milk and first true molars. The former has 9 plates; the latter is in germ.

Figs. 10 and 10 *a*.—*Elephas Hysudricus*. Fragment of lower jaw, with the first true molar, presenting 12 plates.

Figs. 11 and 11 *a*.—*Elephas Hysudricus*. Fragment of lower jaw, with penultimate ? true molar, presenting 12 plates.

Figs. 12 and 12 *a*.—*Elephas Hysudricus*. Fragment of lower jaw, with last molar, entire, *in situ*. The tooth is more elongated, and includes a greater number of divisions (17 or 18) than is usual in the last inferior grinder of *E. Hysudricus*. The specimen is now cut into sections.—B.M.

Plate VIII.

Fig. 1.—*Elephas Hysudricus*. Specimen of cranium in Mr. W. Ewer's collection. Shows the palate with the first and second true molars and tusks on both sides; the first well worn, and partly ground away in

front; the second has the first four ridges well worn. The molars consist of ten ridges and a large heel ridge, eleven in all. The tusks of the opposite sides do not correspond, the left being nearly circular and the right oval. One large sub-orbital foramen.

Depth from back molar to the front at top of incisives, 17·5 in. Contraction of muzzle at sub-orbital foramen, 13·8 in. Breadth, outer surface maxillaries, 9·1 in. Vertical diameter, left tusk, 5·7 in. Transverse diameter, 5·1 in. Greatest diameter, right tusk, 6·2 in. Least, 4·3 in. Interval between teeth in front, 2·2 in. Behind, at niche of palate, 3· in. Length of anterior (first true) molar, 4·1 in. Width, 2·7 in. Number of ridges remaining, 5 and a heel. Length of left back molar, 8· in. Width in front, 3· in. Number of ridges, 10 and a large heel.

Figs. 2 and 2 *a*.—*Elephas planifrons* (misnamed *E. Hysudricus* in plate). Very perfect specimen of lower jaw. Has three mentary foramina on the right side, only two on the left; none on either side at the symphysis. The beak is very deep and thick, and appears to have terminated bluntly. The enamel is very thick. The teeth are certainly the last of the lower jaw, with few points to the back ridges. The slope of wear inclines very much from the outside inwards, the difference being nearly $\frac{3}{4}$ inch, at the third ridge of the left side. The front fang portion has dropped out. Nine ridges remain in the left tooth; on the right side are the remains of ten or eleven. The teeth are very broad, and there is considerable mesial expansion.—B.M.

Extreme length of right side, 24· in. Divergence of rami behind, 21·6 in. Height to front of alveolus, right side, 8·3 in. Greatest thickness behind, 6·7 in. Length of right molar, 8·8 in. Greatest width, 3·8 in. Distance between the teeth in front, 2·8 in. Divergence of teeth behind, 5·6 in.

Fig. 3.—*Elephas Hysudricus*. Lower jaw of small-sized adult. The inside only of this specimen has been figured, and only the portion from the last ridge backwards as a fragment. It is a very old jaw with the last molar. The anterior part of the tooth had dropped out. The last ten ridges remain, all of them worn. The enamel is thick, but very much crimped, and the plates are close together. The condyle is broad and very convex, and the long axis, instead of being transverse, runs obliquely fore and aft. The edge connecting with coronoid commences immediately below the condyle, instead of sloping down with a narrow neck as in *E. planifrons* (See Plate XI. fig. 3).—B.M.

Extreme length of jaw, 19· in. Height of ramus to top of condyle, 17·7 in. Transverse diameter of condyle, 4·5 in. Antero-posterior diameter, 2·8 in. Greatest thickness of ramus behind, 5·7 in. Antero-posterior extent of ascending ramus, 9·6 in. Height to alveolus, 6·2 in. Length of remaining portion of molar, 9·5 in. Width, 3·1 in.

Fig. 4 (and Plate XIII. A. fig. 7).—*Elephas Hysudricus*. Beautiful specimen of entire lower jaw, with two molars. The number of plates in the anterior molar is nine, with a front ridge and a small heel, inner side. Nine plates of the next following tooth are seen in germ. From H. F.'s collection.—B.M.

Extreme length, including beak, 16·6 in. Extreme divergence of rami behind, 14·1 in. Height to alveolus, 4·4 in. Height of condyle, 11·2 in. Antero-posterior extent of ascending ramus, 7·4 in. Greatest thickness behind, 3·8 in. Length of anterior right molar, 5·4 in. Width, 2·3 in. From inner side of symphysis to tip of beak, 3·3 in.

Fig. 5.—*Elephas Hysudricus*. Extremely old lower jaw, right side, with the last tooth nearly worn out, and showing about five remaining

plates extremely distorted. Belonged to an individual of small size. The figure is chiefly intended to show the distortion.—B.M.

Plate IX.

Elephas planifrons (Falc. and Caut.), from the Sewalik hills. Front view of skull, one-third of natural size. The forehead of this species is very flat; the naso-maxillary opening very small, and the occipital fissure very low.—B.M.

Plate X.

Elephas planifrons. Four different views of same cranium as figured in Plate IX. The last true molar is seen in germ and intact on the right side, and well worn on the other, so that the corresponding tooth on the right side of the lower jaw had probably been wanting. It has eleven ridges and a heel. The pterygoids are very low.—B.M.

Extreme length of cranium from occiput to broken incisives, 25· in. Extreme width of occiput, 21·7 in. Height of occiput (condyles broken), 13·7 in. From middle of occipital notch to tip of nasals, 11· in. Transverse diameter of nasal opening, 8·7 in. Vertical, 2·8 in. Interval from posterior orbital process to margin of nasal opening (partly broken), 8·3 in. Estimated width at posterior orbital processes, 27·8 in. Greatest contraction between the temporals, 14·7 in. From occiput to anterior margin of orbits, 20·7 in. Width of muzzle at orbital foramina, 12·5 in. Depth from surface of molar to brow at contraction between the temporals, 16· in. Antero-posterior diameter of orbit, 4·6 in. Transverse ditto, 4·5 in. Length of right molar, 9·7 in. Greatest height of crown plates, unworn, 4· in. Width of crown in worn tooth, 3·5 in.

Plate XI.

Fig. 1.—*Elephas planifrons.* Fine specimen of old palate, with last molar of either side. A section was made of the right molar, which consisted of ten ridges, back heel inclusive. The section showed the anterior fang complete; the enamel very thick; general expansion of the plates; points in the plates very few, fewer even than in *E. insignis.* Specimen in Mr. W. Ewer's collection (See note, page 433, No. 1).

Length of last molar, left, 11· in. Width in front, 4·5 in. Width at seventh ridge, 3·5 in. Interval between the teeth in front, 2·6 in. Interval behind at niche of palate, 5·4 in.

Fig. 2.—*E. planifrons.*—Superb specimen of lower jaw. It has two mental foramina placed, as in fig. 3, much worn in front. The last true molar is beautifully preserved on either side. They have thirteen principal ridges, and a back heel and front ridge; enamel very thick; points few; an intermediate mammilla, the detrition of which causes the mesial expansion; the tooth curves a good deal out. No long spout as in *E. Africanus.* From Sir Proby Cautley's collection (See note, page 434, No. 2).—B.M. (Reproduced in Plate VI. of vol. ii.)

Extreme length of jaw, 19·2 in. Divergence of rami behind (outer surfaces), 19· in. Height to anterior margin of alveolus, 8· in. Greatest thickness behind, 6·5 in. Interval between teeth in front, 3·6 in. Interval behind, 5·6 in. Length of right molar, 11·8 in. Width of right molar in front, 3· in. Width behind, 2·8 in.

Fig. 3.—*E. planifrons.* Superb specimen of left half lower jaw, entire. The coronoid crescent slopes downwards from the condyle. Crown of the tooth very low. Seven last plates of tooth only remain; great thickness of enamel and abundant cement, and mesial expansion;

enamel plates projecting. Proved to be *E. planifrons* by the distance between the plates, the very low crown, thick enamel, and two mental foramina.—B.M.

Extreme length of jaw, 24·2 in. Height of alveolar margin, 7·5 in. Height of ascending ramus to top of the condyle, 20·2 in. Width of ascending ramus from coronoid margin to posterior edge, 10·5 in. Greatest thickness, 6·1 in. Transverse measurement of condyle, 4·2 in. Length of molar, 10· in. Width of molar at middle, 3·6 in.

Fig. 4.—*E. planifrons.* Is a most remarkable fragment of the last molar, upper jaw, right side, taken out of a palate in H. F.'s collection. It is figured to show how diversified the species may be, and also the dedalian line of flexure.

Length of fragment, 5·4 in. Width, 2·5 in.

Fig. 5.—*Elephas planifrons.* Enormous tooth-fragment, with very thick enamel, low plates, and mesial expansion. This specimen is twice figured (See Plate XVIII. A. fig. 2). It is the last molar, lower jaw, right side.—B.M.

Length, 10·5 in. Greatest width, 4·2 in. Height of ninth plate, 3·5 in. Number of ridges, 9.

Fig. 6.—*Elephas planifrons.* Lower jaw, left side, with first and second (antepenultimate and penultimate) true molars. The first tooth is much worn; shows about six plates; enamel transverse with little crimping. The penultimate has nine ridges and a small heel, or eight and a double heel; the two front ridges barely touched. The ridges have few points, the fourth having only five. (*Vide E. insignis*, Plate XVIII. fig. 7).—B.M.

Length of front molar, 6· in. Greatest width, 2·8 in. Length of penultimate, 8· in. Width at fourth ridge, 2·8 in.

Fig. 7.—*E. planifrons.* Left side of lower jaw, with last molar very old. All the first half of the grinding ridges worn out. Very great expansion of the plates. Three mental foramina outside.—B.M.

Length of molar, 10·2 in. Greatest width, 4· in.

Fig. 8.—*E. planifrons.* A magnificent typical specimen, consisting of a fragment of the lower jaw with whole length of penultimate true molar; the anterior fang exposed; the three first ridges on this fang gone by wear; eight other ridges, making eleven ridges and a heel; enamel very thick; plates wide apart; much cement; few points; three mental foramina.—B.M.

Height of jaw to alveolar margin, outer side, 8·6 in. Greatest thickness, 6·4 in. Length of molar, 12·1 in. Width at fourth ridge, 3·6 in. Greatest width, 3·8 in.

Fig. 9.—*Elephas planifrons.* A fragment of last lower molar, left side, intended to show the large digitations and few points of the species. It has the three last ridges and a heel; points very distinct, and enamel very thick; ridges very low; resembles Plate XVIII. A. fig. 1.—B.M.

Fig. 10.—*E. planifrons.* Lower (upper in MS.) jaw, left side, with penultimate and last molar. The whole of the penultimate much worn; the two front ridges worn out; has eight ridges and a very small heel. The tooth is very broad for its length; has a great abundance of cement; the enamel is very thick; figured for the remarkable fact of

there being no crimping whatever, only a little flexuosity, and no mesial expansion. Last tooth is quite untouched by wear.—B.M.

Length of penultimate, 7· in. Width of ditto behind, 3·7 in. Length of first five ridges of last tooth, 5·6 in. Width at third plate, 3·7 in. Height of fifth plate unworn, 3·8 in.

Plate XII.

Figs. 1 and 1 *a*.—*Elephas planifrons*. Antepenultimate milk molar of upper jaw, with four ridges; drawn of natural size. Fig. 1 *b* shows a vertical section of same tooth.

Fig. 2.—*E. planifrons*. Section of second milk molar, upper jaw, right side. It has six main ridges, and back talon and front heel. The four front ridges are touched by wear; great quantity of cement and thick enamel. Resembles the third milk molar in Plate VI. figs. 4 and 5.—B.M.

Length, 3·8 in. Greatest width, 2·3 in.

Fig. 3.—(None in the plate).

Figs. 4 and 4 *a*.—*E. planifrons*. First true molar, upper jaw, much worn, showing five ridges and a heel remaining; two ridges probably gone.—B.M.

Length, 5·2 in. Width, 2·8 in.

Fig. 5.—*E. planifrons*. Fragment of upper jaw with first and penultimate true molar. The first molar is that numbered as fig. 4. The penultimate has eight ridges and a front heel. The specimen is broken behind, but the artist in the drawing has repaired the eighth ridge and added a little. Another first true molar in Plate VI. fig. 5 (See also note, page 427).

Length of penultimate, 8· in. Width, 3· in.

Fig. 5 *a*.—*E. planifrons*. Is a distinct specimen from fig. 5. It is a most valuable palate specimen, showing entire the penultimate or second true molar on either side. On the left side the cavity for the last molar is seen. The penultimate has eight distinct ridges and a front and back heel; all the ridges are more or less worn; the points are few and large, and the enamel thick. Has all the characteristic marks of *E. planifrons*. Specimen in Mr. W. Ewer's collection.

Length of left molar, 7·5 in. Width in front at third plate, 3·2 in. Width at last or eighth ridge, 2·6 in. Interval between teeth in front, 3·2 in. Interval behind, 5·4 in.

Figs. 6 and 6 *a*.—*E. planifrons*. Penultimate true molar *in situ* in upper jaw of a large animal. Tooth has eight main ridges.

Figs. 7 and 7 *a*.—*E. planifrons*. This is a beautiful little specimen of right side of lower jaw, containing the second milk molar. It shows a very small front splent, with six main ridges and a small heel limited to the inner two-thirds of the width of the last plate. Has exactly the same number of ridges as the corresponding tooth in young African Elephant (six main plates), but is a larger and broader tooth. The first three plates are worn. The specimen also shows at *b* the fang-holes of the first milk molar.—B.M.

Length, 6·2. Height to alveolar margin in front, 3·2 in. Ditto behind, 2·7 in. Greatest thickness, 2·6 in. Length of second milk molar, 2·4 in. Greatest width of crown at fourth ridge, 1·4 in.

Figs. 8 and 8 *a*. *Elephas planifrons*.—Left side of lower jaw. This is a superb specimen. It displays three teeth *in situ*, viz. in the

posterior extremity the last milk molar; in front of it the penultimate milk molar (*b*), nearly worn out, and emerging from below the latter a small vertically succeeding premolar (*c*). The third or last milk molar has seven main ridges, with a double front heel and a small splent behind; the four front ridges are worn; it is broader behind than in front; the reverse in the upper.—B.M.

Length of last molar, 4·4 in. Width at second ridge, 1·8 in. Width behind (greatest), 2·4 in. Length of small premolar, 1· in. Width behind, ·8 in.; does not show the ridges.

Fig. 9.—*Elephas planifrons.* Shows at *c* the penultimate premolar. It is considerably smaller in all its dimensions than the antepenultimate milk molar (fig. 1 *a*), drawn to the same scale. It is of a roundish form, and shows no distinct indication of ridge-divisions. It was, therefore, of small importance, functionally, in the economy of the species.

Figs. 10 and 10 *a.*—*Elephas planifrons.* This is an invaluable specimen. Proved by its size and development to be the first true molar, lower jaw, left. Shows seven main ridges and a small ridge in front; no heel behind, or only a very small one; is broader behind than in front; the five first ridges are worn; enamel very thick with mesial expansion; few points to the plates; much cement. The most interesting point is the third premolar (*b*) in front *in situ*. The back part of it only seen; it had not protruded through the jaw. Shows a last plate of three points and a small heel.—B.M.

Length of fragment of jaw, 8· in. Height to alveolar margin, 5·9 in.; greatest width, 4·4 in.; greatest height to crown behind, 6·8 in. Length of the first true molar, 6·7 in.; width in front, 2·3 in.; greatest width behind at fourth-ridge, 2·6 in. Length of premolar fragment, 1· in.; height of crown, 1·5 in.; width, 1· in.

Fig. 11.—*Elephas planifrons.* Last premolar (*b*) vertically divided through the middle, the anterior portion being wanting. Although partly emerged, it is still embedded in the alveolus and intact, while the tooth behind it is well worn. It is of comparatively small size, but presents distinct indications of two transverse ridges terminating in the thick digitations characteristic of the species. This figure refers to the same specimen as fig. 10, but is drawn on a larger scale.

Figs. 12 and 12 *a.*—*Elephas planifrons.* This appears to be the last true molar, lower jaw, right side; has ten main plates, with a front plate and heel; is apparently of a small sized individual; has the enamel straighter in the bend than usual; ridges low.—B.M.

Length, 10· in. Width in front, 3·5 in.; ditto behind, 2·9 in. Height of crown at seventh plate, 4· in.

Fig. 13.—*Elephas planifrons.* Lower jaw, left side, with last true molar entire; crown not figured; very thick enamel plates reclined; considerable mesial expansion; points in the back plates few; in the front plates a good deal of crimping; shows about thirteen ridges and a heel, or possibly fourteen. Resembles very much an unfigured specimen in H. F.'s collection (See note, page 434, No. 3).[1]—B.M.

Length of molar, 12·7 in.; width, 3·6 in.; height at tenth ridge. 4·5 in.

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[1] The following notes refer to unfigured specimens of *Elephas planifrons*:—

1.—The most characteristic specimen of this species consisting of the last molar, upper jaw, has not been figured. Its measurements are: extreme length, 11· in.; width in front at second ridge, 3·7 in.; ditto at eighth ridge, base, 3·8

Fig. 13 *a*.—*Elephas Hysudricus*. (Has no connection with fig. 13. Is misnamed *E. planifrons* on plate). It is the last molar, right side, lower jaw. Has a peculiar slew or twist in the wear, in front from the inside out, and behind from the outside inwards. Is an enormous tooth. Shows the anterior fang in section, only one or two plates gone; enamel very thick and plaited; mesial expansion. Has ten plates and a heel.—B.M.

Length of tooth, 11·3 in.; width in front, 3·9 in.; in middle, 4·4 in. Height to alveolar margin, 9· in. Height of jaw to crown of molar behind, 9· in. Greatest thickness of jaw, 6·3 in.

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in.; ditto at eighth ridge, near apex, 2·4 in.; height at eighth ridge, measured from reflection of enamel plates below, 4·8 in. Number of principal ridges twelve, with a front ridge and heel. This tooth resembles very much in wear Mr. Ewer's specimen, Pl. xi. fig. 1, and H. F.'s specimen, Pl. xii. fig. 5. Of the 12 plates composing it, the first eight are touched by wear. The front subordinate ridge is joined on by a neck or reduplication of enamel to the first principal ridge. The enamel is very thick. There is a good deal of crimping in the first three ridges, but no great amount of mesial expansion. The points are few in number, there being only six which are worn into round rings to the seventh ridge. A comparison of this tooth with the last upper molar of *Elephas Hysudricus* is as follows:

	E. planifrons Inches	*E. Hysudricus* Inches
Extreme length of last upper molar	11·0	11·0
Width in front at 2nd ridge	3·7	3·4
Width at 8th ridge	2·4	3·3
Height at 8th ridge	4·8	5·4

2.—A superb specimen of the lower jaw in H. F.'s collection. The specimen has the left molar entire; of the right, only the first eight ridges remain; all the ridges on to the heel are worn. Enamel very thick with beautifully marked mesial expansion, forming a sharp loop. The back loop of one plate nearly in contact with the front lamina of the next ridge! Is a most beautiful and characteristic specimen. The beak, although broken, projects sufficiently to prevent the ramus from resting on its lower surface. The diastemal ridges are not raised as in *E. antiquus* (*E. meridionalis* in note of date about 1846, see note, p. 443), but form a broad flat beak (not sharp and narrow, as in *E. insignis*) which projects downwards as in the African Elephant, although it is more abruptly bent down, shorter and flatter, something as in *E. primigenius*. In this respect the specimen is more perfect than Pl. xi. fig. 2. The molars are nearly parallel in front, and diverge afterwards. There are three outer mentary foramina, and one on the inside. The backmost foramen begins below the front fang of the molar; the two others are on the same sloping line in front.

Extreme length, 21·6 in. Height to alveolus, 7·5 in. Greatest width, 7·7 in. Interval between teeth in front, 3·8 in. Width of diasteme, just below the beginning of the symphysis, 3·5 in. Length of the left molar, 11·0 in.; width at third ridge, 2·9 in.; greatest width in the middle, 3·3 in.; height of 8th plate, 3·0 in.; number of plates, 13 and a heel.

3.—Specimen of the entire last lower molar, right side, contained in a mutilated lower jaw. This magnificent specimen shows the entire length of the tooth, and a small portion of the penultimate in front of it. The seven anterior ridges are touched by wear. The enamel is very thick with a mesial expansion and somewhat crimped. The sixth ridge shows six annular discs; the seventh only five points. The tooth is very broad; much cement; the last plate or heel is an oblique splent of only three or four irregularly placed points. The fang projects behind it. The tooth in its direction curves much outwards, and is very nearly of the same width from back to front.

Extreme length of last molar, 11·8 in. Extreme width at sixth ridge, 3·9 in. Height at eleventh plate, 4·6 in. Number of principal ridges 14, and a small heel of three points.

Plate XII. A.

Elephas Namadicus (Falc. and Caut.) From the valley of the Nerbudda. Probably a female, from small size of tusks. This specimen was presented to the Museum of the United Service Institution by Major Orlando Felix, and was received by him with other Nerbudda specimens, from Lieut.-Colonel Ouseley. It was chiselled out by Dr. Falconer, and determined by him to be a new species. In a letter to Lieut.-Colonel Ousely, Dr. F. writes thus: 'It is probably the most perfect specimen of a fossil elephant's cranium in Europe. The species is especially interesting from the form of the cranium, which is so grotesquely constructed that it looks the caricature of an elephant's head in a periwig. I have named the species *E. Namadicus*, after the Nerbudda river, the Namadus of Ptolemy.' There is a very similar specimen in the Museum of the Asiatic Society of Bengal (See *antea*, p. 115).—Specimen is now in B.M.

Extreme length from occipital bosses to molar surface, 29·8 in. Extreme width of occiput, 30·0 in. From plane of occipital bosses to tip of nasals, 17·4 in. From bottom of fossa of bosses to tip of nasals, 12·9 in. From bottom of bosses to anterior margin of frontal bulge, 10·5 in. Depth of occipital fossa below the plane of the bosses, 7·5 in. Length of crista galli-like plate, 11·2 in. Greatest contraction of brow between the temporals, 20·0 in. Projection of frontal bulge above plane of forehead, 2·7 in. From anterior margin of orbit to occipital bosses, 24·8 in. Width of deep occipital fossa, 5·6 in. Transverse extent nasal opening, 15·0 in. Vertical height of nasal at sides, 5·3 in. Width of brow between middle of orbits, 20·0 in. Width between tips of posterior orbital processes, 25·0 in. Antero-posterior diameter right orbit, 6·2 in. Width of base of muzzle at contraction of the sub-orbitaries, 10·8 in. Interval between outside of maxillaries, 10·1 in. Vertical diameter sub-orbitary foramen, 3·1 in. From auditory foramen to anterior margin of orbit, 14·0 in. Transverse diameter, right tusk, 2·9 in. Vertical diameter of right tusk, 2·5 in. Depth of temp. fossa from ear (foramen auditor.) to frontal margin of fossa at contraction, 13·3 in. Interval across the occipital condyles, 9·7 in. Antero-posterior diam. left condyle, 4·6 in. Transverse, 3·2 in. Antero-posterior diam. occipital foramen, 3·0 in. Transverse diameter occipital foramen, 3·6 in. From anterior margin occipital hole to posterior of surface palate, 13·9 in. Length of palate from niche to diasteme, about 8·4 in. Width of base of skull at posterior end of zygoma, 26·2 in. Width between ridge of pterygoids, 9·1 in. Height of pterygoid ala of sphenoid above Vidian hole, 10·0 in. Length of articular surface for lower jaw, 5·1 in. Across articular surface for lower jaw, 3·3 in. Length of remaining portion left molar, 7·5 in. Width of remaining portion left molar, 3·7 in. N.B.—Twelve plates in this extent. Width of palate in front (between molars), 2·8 in. Width behind, 4·1 in.[1]

[1] *Memorandum upon the Nerbudda Fossil Elephant, India House specimen.*

Measurements of the sixth or last True Grinder	Elephas Namadicus	Assam, recent	Corse's large specimen Brit. Mus.	Elephas Hysudricus	Elephas primigen.
	Inches	Inches	Inches	Inches	Inches
Length of the eleven anterior plates measured near the base	8·1	5·7	5.6	7·7	4·5
Width or thickness of the ivory core, third plate, one inch above the base .	0·45	0·2	...	4·5	...
Width or thickness of the ivory core, fifth plate, one inch above the base .	0·5	0·2	...	0·35	0·3

PLATE XII. B.

Figs. 1, 2, and 3.—*Elephas Namadicus.* Three different views of same skull as figured in Pl. XII. A. The molars are less perfect than

Memorandum upon the Nerbudda Fossil Elephant—continued.

Measurements of the sixth or last True Grinder	Elephas Namadicus	Assam, recent	Corse's large specimen Brit. Mus.	Elephas Hysudricus	Elephas primigen.
	Inches	Inches	Inches	Inches	Inches
Width or thickness of the ivory core, eighth plate, one inch above the base .	0.55	0·2	...	0·35	...
Width or thickness of the ivory core, eleventh plate, one inch above the base .	0·5	0·2	...	0·25	...
Average thickness of enamel plates	0·2	0·1	...	0·15	...
Height of enamel plate, tenth ridge . . .	7·5	7·4	...	4·8	6·2
Greatest width of tooth, at fourth plate . . .	...	...	3·5	3·5	...

The specimen is upper jaw, right side, with the last grinder of which the eleven anterior plates remain; there must have been several more behind, from the great height of the last plate. On comparing the section with that of the *E. Hysudricus* and existing Indian species, it is at once seen to differ from the former in the extreme height of the plates, from their slight amount of thinning upwards and their nearly vertical direction. They are as straight and vertical as in the Mammoth. There is besides no loop about the middle of the tooth plates, in the enamel and comparatively thin crusta. It is assuredly different from the *E. Hysudricus.* As compared with the existing species, the ivory is very much thicker, with *no curve* towards the apex; the enamel plates are very much thicker also. The crown of the plates resembles very much the last tooth of Corse's big head in the transverse direction of the plate ribands, and in the excessive amount of crimping or fine plaiting of the enamel. From the measurement given it will be seen, however, that the enamel and ivory in thickness indicate a wide difference, which is further borne out by the verticality of the plates. Having seen nothing among the existing teeth of a range of difference at all approaching this, I am compelled to consider the species, as far as my present information goes, as distinct. There is no possibility of considering it a variety of *E. Hysudricus.* I call it therefore provisionally *Elephas Namadicus* (from the Greek name of the Nerbudda 'Namadus'). It was found along with Hippopotamus, Buffalo, &c., in the Nerbudda. There must have been at least nine or ten plates more, and it would rank in place between the existing Indian elephant and the *E. Hysudricus*—

Thus, *E. primigenius,*
E. Indicus,
E. Namadicus,
E. Hysudricus,
E. planifrons, &c.

The inferred distinctness of species is further borne out by the excessive width of palate in the other Nerbudda specimen, seven inches behind. The Perim species is probably the same.

N.B.—Prinsep, in the Journal of the Asiat. Society of Bengal, vol. iii. p. 585, describes and figures the lower jaw, one side nearly entire, of a fossil Elephant from the Nerbudda, which he states to be so like the existing Asiatic Elephant, judging from a comparison with a jaw in the Calcutta Museum, that it was impossible to distinguish them, although it may be confidently distinguished from the *E. primigenius.* The figure shows about fifteen or sixteen plates in wear, and at least seven more behind, or twenty-three to twenty-four in all. The rami, however, as sketched by Prinsep, are much more apart than in the Asiatic species generally. Dimensions: length, 11½ in., width in the middle, 3½ in.; transverse diameter of jaw at coronoid disc, 6 in., and girth of jaw in front of coronoid, 24 in.

This in all probability belongs to the *Elephas Namadicus,* as also the prodigiously large humerus at the India House.

in the corresponding specimen in the Museum of the Asiatic Society of Bengal (See *antea*, p. 115).—B.M.

Fig. 4.—*Elephas Hysudricus*. This fragment of skull, which is probably female, and is but very slightly concave on the forehead, yields very few good measurements. The figure is chiefly given for the form. It has two small tusk sheaths; the tusks are broken off near the base of the nucleus, and show only a thin plate. Only one orbital foramen, very large. This specimen is very remarkable in the molars having so few plates, only eight to the first true molar and no heel.—B.M.

Length of penultimate molar, 5·2 in.; width, 2·3 in. The penultimate entirely in germ shows eleven plates. Extreme length of the fragment, 28·5 in. Length from occiput to tip of nasals, 18·0 in.; width of nasal opening, 12·5 in.; width of brow across orbits, 21·6 in. Interval between the teeth in front, 2·1 in.; interval at niche of palate, 3·8 in.; diameter of the right tusk, 2·5 in.

Plate XII. C.

Figs. 1 and 1 *a*.—*Elephas Namadicus*. A small fragment of lower jaw, with three plates of what is probably the first true molar.—B.M.

Figs. 2 and 2 *a*.—*Elephas Namadicus*. Lower jaw, left side. This specimen contains the third milk molar well worn and the first true molar in germ.—B.M.

Extreme length, 12·5 in. Height at alveolus, 4·1. Thickness of jaw behind, 4·0 in. Length of anterior molar, 5·2 in.; width, 1·8 in. Number of plates remaining, 7.

Figs. 3 and 3 *a*.—*E. Namadicus*. Young lower jaw, right side, with third milk molar, which has ten ridges and a heel. The crimped character of *Elephas antiquus*[1] is well shown. A small vertebra is attached to the ramus.—B.M.

Length of fragment, 11·0 in. Height at alveolus, 4·8 in. Thickness behind, 4·0 in. Length of third milk molar, 5·5 in.; width, 1·9 in.

Figs. 4 and 4 *a*.—*E. Namadicus*. Right lower jaw of adult, containing last molar with twenty plates and a heel. The specimen shows two mentary foramina. The broken coronoid portion of the ramus shelves more out than in *E. antiquus*,[2] and the mentary foramina are placed higher. Presented by C. Frazer, Esq.—B.M.

Extreme length of fragment, 23·6 in. Height at alveolus, 9·2 in. Length of the molar partly concealed and chiselled, 14·7; width, 3·11 in. Width of jaw behind, 8·0 in.

Figs. 5 and 5 *a*.—*E. Namadicus*. Adult lower jaw of large size. The specimen does not show the beak distinctly, and is more obtuse there than in *E. antiquus*.[3] The number of outer mentary holes is uncertain, as in *E. antiquus*[4] there is no inner hole. Presented by C. Frazer, Esq., and described in Journ. Asiat. Soc.—B.M.

Extreme length, right side, 20·5 in. Expansion of rami, 24· in. Height of jaw at beginning of alveolus, 10· in. Length of right molar, 14· in. Width, 3·7 in. Number of plates remaining about 15. Greatest width of jaw, 8·1 in.

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[1] '*Elephas meridionalis*' in original notes, written about 1846. The close resemblance of the *E. Namadicus* from the Nerbudda to the *E. antiquus* of the oyster beds of Norfolk coast, in England, is dwelt on in the memoir on Elephants, in vol. ii. See also note, p. 443.

[2] See last note.

[3] See note 1.

[4] See note 1.

Figs. 6 and 6 *a*.—*Elephas Hysudricus*. Lower jaw, left side, with first true molar which has ten plates, with a small heel and front ridge. It is excessively like Plate VII. fig. 11, which is the penultimate of *E. Hysudricus*. The specimen is very remarkable as it is believed to have come not from the Sewalik hills, but from the valley of the Nerbudda; the mineral condition, however, is very hard, unlike the Nerbudda specimens. Presented by C. Frazer, Esq.—B.M.

Length of molar, 8· in. Width, 2·6 in. Height at 8th plate, 4·2 in.

Plate XII. D.

Figs. 1 and 1 *a*.—*Elephas Namadicus*. Beautiful specimen of lower jaw, left side, containing the first true molar with thirteen ridges, and a heel and front ridge, fifteen ridges in all.—B.M.

Extreme length, 16·2 in. Height at alveolus, 6·3 in. Length of molar, 7·4 in. Width, 2·2 in.

Figs. 2 and 2 *a*.—*E. Namadicus*. Lower jaw, right side. This is a little larger than the last specimen, and contains the first true molar with about thirteen ridges. All these specimens show two highly-placed mentary foramina. Part of the molar is concealed behind. A portion of the third milk molar is seen in front.—B.M.

Extreme length, 19·5 in. Height at alveolus, 6·4 in. Length of molar, 7·3 in. Width, 2·5 in. Width of jaw behind, 6·4 in.

Figs. 3 and 3 *a*.—*E. Namadicus*. Lower jaw, left side. This is a most beautiful specimen, containing the second true molar. The alveolus of the last tooth is shown behind. It contains about fifteen plates, twelve to thirteen of which remain. The whole length of the tooth is present. It narrows very much in front. N.B.—Another specimen of same jaw, opposite side, not figured, is exactly similar.—B.M.

Extreme length, 13·6 in. Length of molar, 10·2 in. Width at middle, 3·3 in.

Figs. 4 and 4 *a*.—*Elephas antiquus*.[1] Lower jaw, left side, with first true molar. This tooth is a beautiful specimen; shows twelve to thirteen ridges, with front ridge and heel. It narrows excessively in front and behind, like fig. 3 of *E. Namadicus*! The crimping, &c., are also exactly alike.—B.M.

Length of molar, 8· in. Width at middle, 2·6 in. Width in front, 1·3 in.

Figs. 5 and 5 *a*.—*Elephas antiquus*.[2] Last? molar of upper jaw, right side, showing sixteen ridges and a small heel, much worn. Specimen belonging to the Canterbury Museum and labelled '$\frac{2}{2}$ Tooth of Mammoth, Kent.'

Length, 10·8 in. Width, 3·3 in. Extreme height, 6· in.

Plate XIII.

Figs. 1, 1 *a*, and 1 *b*.—*Elephas Namadicus*. Fragment of upper jaw, right side, containing eleven plates of the 6th molar or last true grinder. Fig. 1 *a* shows well the crimping of the enamel, and fig. 1

[1] Misnamed '*E. meridionalis*' on plate, but corrected by Dr. F. in copy of 'Fauna Antiqua Sivalensis,' belonging to British Museum. See also note, page 443.

[2] See last note.

shows a longitudinal vertical section of the tooth. Presented by C. Frazer, Esq., to India House.—B.M.

Length, 7·9 in. Width behind, 2·5 in. Width in front, 4·2 in. Height anteriorly, 2· in. Height posteriorly, 8·4 in.

Figs. 2 and 2 *a*.—*Elephas Namadicus*. Palate with sixth or last molar on both sides. Presented by C. Frazer, Esq.—B.M.

Length of fragment of grinding surface of molar of right side, 7·3 in. Greatest breadth posteriorly, 3· in. Length of fragment of left side, 6·9 in. Width posteriorly at first plate, 2·6 in. Width at fifth plate, 3·8 in. Width of palate posteriorly, 5·3 in. Width of palate anteriorly, 4·9 in.

Figs. 3 and 3 *a*.—*Elephas Namadicus*. Fragment of upper true molar with six plates; enamel crimped.

Length of fragment, 4·2 in. Width at second plate, 2·9 in. Width of posterior plate, 2· in. Greatest height, 6·1 in.

Plate XIII. A.

Lower Jaws of Elephants viewed from above.

Fig. 1.—*Elephas primigenius*. Old. One mentary foramen inside and three outside. Right true molar has thirteen plates, and measures 9·4 in. in length, and 3·6 in. in width.

Fig. 2.—*E. primigenius*. Young. Contains the antepenultimate or first true molar on either side with twelve ridges, and a small heel and front ridge, all of which, except the posterior talon, are affected by wear. The plates are very fine. The tooth is not so broad relatively to the length as in other specimens. The discs of wear form closely compressed transverse bands, with attenuated plates of enamel. Some of these plates differ from the ordinary type of the Mammoth in exhibiting a certain amount of irregular crimping, but in no degree approaching that seen in the Indian Elephant, this character concurring with a less than ordinary width of crown. The penultimate true molar is seen in germ behind. There is one inner mentary foramen on either side. A Rhine specimen from Dr. Kaup.

Extreme length of jaw, 16·8 in. Extreme expansion behind, 16· in. Height to broken condyle, 12·5 in. Height to alveolus, 4·7 in. Thickness of jaw at middle, 4·8 in. Length of molar, 5·4 in. Width, 2·2 in.

Fig. 3.—*E. primigenius*. English fossil specimen, with two last true molars on either side. In the last left molar there are eighteen plates in 7·7 inches. The jaw has a short beak, and one inner mentary foramen on either side. In this, as in figs. 1 and 2, representing the jaw at different ages, it is to be noted that the opposite lines of molars are more or less convergent instead of being parallel, or nearly so, as laid down by Cuvier.—B.M.

Extreme length of jaw, 23·6 in. *Divergence of rami behind, 21·3 in. Height at* alveolus, 7·2 in. Greatest width of jaw, 6·3 in. *Breadth of condyle, 10·3 in. Width* of last molar, 2·8 in.[1]

Fig. 4.—*Elephas antiquus*.[2] Lower jaw with penultimate and last true molars on either side. The last molar is very perfect and has seventeen plates, of which the nine anterior ones only are worn. Only six plates of

[1] Another lower jaw of *E. primigenius*, not figured, from Siberia, contains the last molar only, very much worn. It has thirteen plates in 8·9 in., is very narrow, and has hardly any crimping. It has one large outer mentary foramen in front and one inside. It is very circular in outline in front.

Extreme length, 22·5 in. Height to condyle, 18·7 in.

[2] Misnamed '*E. meridionalis*' in Plate.

See notes pages 438 and 443.

the penultimate are seen. No mentary foramen. Specimen in Geological Society's Museum. (Reproduced in Plate IX. of vol. ii.)

Extreme length of jaw, 26· in. Divergence of rami, 24·5 in. Height at alveolus, 9·2 in. Height to broken condyle, 16·3 in. Breadth of ascending ramus, 11·5 in. Thickness of jaw, 7· in. Length of anterior molar, 3·9 in. Width, 3· in. Length of last molar, 12· in. Width in front, 3·1 in. Number of plates 18.

Fig. 5.—*Elephas antiquus.*[1] Fragment of lower jaw with first true molar on either side. The number of plates is twelve, with a heel. There is no mentary foramen inside. This specimen formerly belonged to the Earl of Aylesbury, but is now in B.M. (*Vide* Pl. XIV. A. fig. 7).

Length of right ramus, 14·5 in. Height, 5·1 in. Length of right molar, 6·7 in. Width, 2·3 in.

Fig. 6.—*Elephas Indicus.* Existing Indian Elephant. Specimen from Malacca in Museum of Asiatic Society. The jaw contains the last molar on either side. The number of plates is twenty-two or twenty-three, of which the eleven anterior are worn.

Extreme length of jaw, 19·3 in. Height of condyle, 18·4 in. Breadth of ascending ramus, 9· in. Thickness of jaw, 5·2 in. Length of molar, 10·4 in. Width, 2·9 in.

Fig. 7.—*Elephas Hysudricus.* Same specimen as figured in Pl. VIII. fig 4. The description and measurements have been already given.—B.M.

Fig. 8.—*Elephas Africanus.* Young lower jaw with two molars (third milk and first true) on left side, and with first true molar and alveolus of third milk molar, right side. The antepenultimate true molar has seven ridges and a back and front talon. From Museum of Asiatic Society.

Plate XIII. B.

Lower jaws of elephants in profile. The numbers correspond to the eight specimens figured in Pl. XIII. A. In these figures, which represent the groups *Loxodon* and *Euelephas*, the back of the symphysis is seen to be a prolongation of the inferior margin into which the diastemal ridges descend with great obliquity and also to be attenuated towards the apex, to terminate in an obtuse point.

Fig. 1.—*Elephas primigenius.* Showing three outer mentary foramina.

Fig. 2.—*E. primigenius.* With two outer mentary foramina on left side. There were four on right side.

Fig. 3.—*E. primigenius.* Two outer mentary foramina.

Fig. 4.—*E. antiquus.*[2] Two outer mentary foramina on left side.

Fig. 5.—*E. antiquus.*[3] Three outer mentary foramina on left side.

Fig. 6.—*E. Indicus.* Five outer mentary foramina on left side.

Fig. 7.—*E. Hysudricus.* One small outer mentary on left side. (See also Pl. VIII. fig. 4.)

Fig. 8.—*E. Africanus.* Three outer mentary foramina on left side.

Plate XIV.

Figs. 1, 1 *a*, and 1 *b*.—*Elephas antiquus.*[4] Second milk molar, lower jaw, left side, with six ridges and a front and back heel, from Grays, in Essex.—B.M.

Length, 2·4 in. Width, 1·3 in.

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[1] Misnamed '*Elephas meridionalis*' in Plate. See notes pages 438 and 443.

[2] See last note.

[3] See note 1.

[4] See note 1.

Figs. 2, 2 *a*, and 2 *b*.—*Elephas antiquus*.[1] Second upper right milk molar, with six ridges and a heel, from Grays, in Essex.—B.M.

Length, 2·4 in. Width, 1·3 in.

Figs. 3 and 3 *a*.—*E. primigenius*, probably (*sic*). Small milk molar: 9 ridges.

Fig. 4.—*Elephas Africanus*. Lower jaw of young animal with first, or antepenultimate, and penultimate milk molars on both sides. The right penultimate molar has six plates and a heel. This is the interesting specimen figured and described by De Blainville.

Length of jaw, 9·7 in. Length of penultimate right milk molar, 2·3 in. Width, ·9 in.

Figs. 5 and 5 *a*.—*Elephas Africanus*. Penultimate right lower molar, with eight ridges and a heel. The ridges are broad, and the fangs supporting the five posterior ridges are confluent.

Length, 7·4 in. Width of crown, 2·4 in. Height of crown at eighth plate, 3·4 in.

Fig. 6.—*Elephas priscus*. Mutilated fragment of penultimate lower molar, left side, from the brick-earth deposits of the valley of the Thames. Shows only the entire discs of five partially worn ridges. The outline of the discs corresponds very closely in form with those of the posterior ridges of the larger specimen from Gray's Thurrock, shown in fig. 7. There is the same mesial angular expansion, and a still greater tendency to the discs assuming a crescentic form. The mutilated state of the specimen renders its identification somewhat doubtful, but it is inferred to belong to *E. priscus*.—No. 18,966 B.M.

Length, 5· in. Width, 3· in. Height behind, 2·8 in.

Figs. 7 and 7 *a*.—*Elephas priscus*. This is a most interesting specimen from Gray's Thurrock, purchased from Mr. Ball, of last lower molar, left side, containing eight ridges, heel inclusive. It is slightly concave on the outside, and convex on the inner side. A small portion of the anterior end—two plates, perhaps—is broken off. The fangs of the whole of the anterior part remain attached. The seven anterior plates are worn down to wide discs; the hind talon has also begun to wear. Is excessively like African Elephant in lozenge-shaped expansion, and in the thickness of the enamel lamellæ. The rhomb form is not so sharply defined in the discs of wear, but the greatest expansion is at the centre, where there is a tendency to an outlying loop (*Vide* fig. 5). Besides the great expansion, this tooth differs from all true *E. antiquus* specimens in the lowness of the crown ridges (*Vide* Pl. XIV. A., *passim*, and especially fig. 8). If not a separate species, is a very marked variety.—No. 39,370 B.M.

Fig. 7 *b*.—Longitudinal section of same molar of *E. priscus*. Shows the closest relation to the existing African Elephant (Pl. II. fig. 4 *b*,) in all that relates to the relative proportions of the alternate layers of ivory, enamel, and cement, and in the cuneiform character of the ridges.[2] (Reproduced in Plate VII. of vol. ii.)

Length of molar, 7·8 in. Width of crown at first plate, 2·35 in.; at second, 2·6 in.; at third, 2·75 in.; at fourth, 2·8 in.; at fifth, 2·7 in.; at sixth, 2·45 in.; at seventh, 1·8 in.; at talon, 1·3 in. Height at seventh plate, 2·5 in. Expansion

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[1] Misnamed *Elephas meridionalis* in Plate. See notes pages 438 and 443.

[2] The differences between *E. priscus* and *E. Africanus* are considered in detail in Dr. F.'s Memoir on Fossil Elephants, vol. ii.

of first plate at the middle, ·8 in.; of second, ·95 in.; of third plate, ·85 in.; of fourth, ·75 in.; of fifth, ·7 in.; of sixth, ·6 in.; of seventh, ·5 in.

Fig. 8.—*Elephas planifrons.* A very fine and characteristic specimen of the last upper molar, right side. Was found in contact with the lower jaw specimen, fig. 9. Shows about eight or nine ridges and a heel; the three first ridges worn out. The enamel is very thick, with irregular lozenge-shaped expansion, and a loop in the middle. The plates stand high in relief from the cement. The denticles are very few and thick, the last ridge showing only three crown plates very low, the last being but 2½ inches high.—B.M.

Length of molar, 10· in. Width of crown, 3·5 in. Height behind, 2·5 in.

Fig. 9.—*Elephas planifrons.* Last lower molar, right side. Is very valuable from having been found in contact with the upper molar (fig. 8). Shows only eight ridges and a heel. The plates are very thick and low. The sixth ridge shows only four denticles. In this and the last figure the discs of wear form transverse bands, which are broader, fewer in number, and wider apart than in the Indian Elephant; the bounding edges of enamel are sometimes nearly parallel; in other cases they show a slight angular expansion, or throw out a salient loop (or outlying) tubercle near the middle.—B.M.

Length of molar, 9·5 in. Width of crown, 3·5. Height of crown at sixth ridge, 3· in.

Fig. 10.—*Elephas planifrons.* Fragment of lower jaw, with antepenultimate and penultimate milk teeth *in situ*.[1]—B.M.

Plate XIV. A.

Molars of *Elephas antiquus*.[2]

Figs. 1 and 1 *a*.—Second upper milk molar, right side, from Kent, with five plates. Specimen in Canterbury Museum.

Figs. 2 and 2 *a*.—Third upper milk molar, right side. Has about ten plates. Specimen from Southwold, in Museum of Geological Society.

Length, 5·5 in. Width, 2·3 in. Height, 2·8 in.

Figs. 3 and 3 *a*.—Third milk molar, upper jaw, left side. Has ten plates and a heel.—B.M.

Length, 6· in. Width, 2·2 in. Height, 3·5 in.

Figs. 4 and 4 *a*.—First true molar, upper jaw, right side. Eight plates. From Southwold. Geol. Soc. Mus.

Length, 5·5 in. Width, 2·6 in. Extreme height, 4·8 in.

Figs. 5 and 5 *a*.—Last true molar, upper jaw, right side. Has fourteen plates and a heel, well crimped. From forest bed, Ostend, Norfolk. Green collection.—No. 16,229 B.M.

Length, 10· in. Width, 3·4 in. Height, 6·5 in.

Figs. 6 and 6 *a*.—Third milk molar, lower jaw, right side, imperfect.

[1] In the plate this specimen is designated *E. Hysudricus*, but this is doubtless an error, as the figure is referred to as that of molar of *E. planifrons* in Dr. F.'s Memoir on Fossil Elephants, vol. ii.

[2] Erroneously designated *Elephas meridionalis* on plate. The error is corrected in Dr. F.'s handwriting in the copy of the 'Fauna Antiq. Sival.' belonging to the British Museum. See also note, page 443.

Has seven well crimped plates. Specimen is from Suffolk, and was presented by Dr. Cooke to Geol. Soc. Mus. (No. 8,411).

Length, 4·2 in. Width, 2·1. in. Height, 3· in.

Figs. 7 and 7 *a*.—Third milk molar, lower jaw, right side, from Kent; not quite perfect behind. Is narrow in front, broader behind, and well crimped. Proves Lord Aylesbury's specimen to be first true molar (*Vide* Pl. XIII. A. fig. 5).

Length, 5·4 in. Width, 2· in. Height behind, 2·5 in.

Figs. 8 and 8 *a*.—First true molar, lower jaw, right side; embedded in fragment of jaw. Has twelve plates.—No. 18,967 B.M.

Length of molar, 8·3 in. Width, 2·5 in. Height, 4·2 in.

Figs. 9 and 9 *a*.—Fragment of lower jaw, right side, with portions of two last molars. The plates are enormously higher than in the *Elephas priscus* from Grays. The specimen is believed to be from Rome, from Cardinal Gualteri's collection.—B.M.

Length of anterior molar (imperfect), 4· in. Width, 3· in. Length of last molar, 7· in. Height of section, 7·3 in. Number of plates remaining, 9.

Figs. 10 and 10 *a*.—This is probably a second true molar, lower jaw, right ride. Has twelve plates and a heel, five of the plates worn.—No. 19,844 B.M.

Length, 10· in. Width, 2·5 in. Height, 6· in.

Figs. 11 and 11 *a*.—Last molar, lower jaw, left side, with fifteen to sixteen plates and a heel. Portion in front gone. Specimen belonging to Mr. Bowerbank. It was brought from Saffron Walden by Mr. Sampson Hancock, and presented to the Mathematical Society at Dover, in whose collection it remained until its dissolution. It then passed into the hands of Mr. J. S. Bowerbank, who has known the specimen for about thirty years. (MS. Note on Plate, March 22nd, 1858.) Reproduced in Plate IX. of vol. ii.

Length, 12·3 in. Width, 3· in. Height, 5· in.

Figs. 12 and 12 *a*.—Last lower molar, right side, from Happisburgh. Only the eleven posterior plates are present. Plates very crimped and bent.—B.M.

Length, 10·5 in. Width, 3·4 in. Height, 5·7 in.

Figs. 13 and 13 *a*.—Last lower molar, left side; fourteen plates remaining, but some in front missing. From Cardinal Gualteri's collection. Via Appia, Rome.—B.M.

Length, 11· in. Width, 3·4 in.

Plate XIV. B.[1]

Figs. 1 and 1 *a*.—*Elephas meridionalis*. Plan- and side-view of the penultimate or second upper milk molar. It is a germ-specimen,

[1] Great confusion has existed with regard to this plate, which I hope to have succeeded in now clearing up. In the published plate (xiv. B.), figs. 1 to 9 and 11 to 16 are said to belong to *E. meridionalis*, and figs 10, 17, and 18, to *E. antiquus*. While the plates of the 'Fauna' were passing through the press Dr. Falconer became satisfied that he had committed a mistake in making the fossil remains of the fluviatile beds of the Thames valley identical with the extinct Elephant of the Val d'Arno, instead of the fossil remains of the 'Crag.' In his memoir on British Fossil Elephants, written ten years later (1857), but not published until after his death, he says that although convinced that the 'Crag'

without fangs, and a good deal rolled. The crown is composed of six principal ridges, besides front and back talons. It was compared with the corresponding tooth of *E.* (*Loxodon*) *planifrons*, which it resembles very closely, but it has a broader crown. The dimensions are :—

Length, 2·6 in. Width of crown at first plate, 1·15 in. Width of crown behind, 1·4 in. Height of crown at fifth ridge, 1·55 in.

The corresponding tooth of *E.* (*Eueleph.*) *antiquus* and of *E. primigenius* yields normally eight transverse plates. The precise origin of the specimen is not recorded; but it is supposed to have belonged to Mr. Samuel Woodward, and to have been derived from the Norfolk coast. Norwich Museum, No. 11.

Figs. 2 and 2 *a*.—*Elephas meridionalis*. Another example of the same tooth, a penultimate upper milk molar, right side, discovered in the Norwich Crag at Easton, Suffolk, by Captain Alexander. It presents six ridges, well advanced in wear. Norwich Museum. The dimensions are :—

Length, 2·4 in. Width in front, 1·0 in. Width behind, 1·6 in.

Figs. 3 and 3 *a*.—*Elephas meridionalis*. Another well-worn penultimate milk molar, probably of the lower (?) jaw, right side. It is of a larger size than the others, but shows the same number of plates, namely six, with talons. It is very broad in the crown relatively to the length. The discs of the ridges are very wide, like the Italian specimens. This molar belonged to the collection of Mr. Samuel Woodward; it is now in the Norwich Museum. It is heavy and dark-coloured, and bears fresh patches of marine incrustation, and may have come from the 'oyster-bed' of Mundesley and Happisburgh.

Figs. 4 and 4 *a*.—*Elephas meridionalis*. The last milk molar of the lower jaw, left side. The crown is worn, and comprises eight ridges. The ends and sides of the crown are partly injured. In mineral condition it is black and heavy, but free from patches of marine incrustation. It is supposed by Mr. Samuel Woodward to have been procured from the coast (Norwich Museum, No. 10). The dimensions are :—

Length of crown, 3·9 in. Width of crown in front, 1·4 in. Width of crown at sixth ridge, 2·0 in. Height of crown at seventh ridge, 2·1 in.

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molars were identical with those of *E. meridionalis*, he had, in order to prevent confusion, continued in the subsequent plates the nomenclature adopted in the earlier ones, intending to give a full explanation of the whole in the letter-press, and he concludes as follows :—'I beg leave to explain now that all the plates bearing the name of *E. meridionalis* in the "Fauna Antiqua Sivalensis," including the outline figures of crania in Plate xlii., belong to *E. antiquus*, while those that bear the latter name belong to *E.* (*Loxodon*) *meridionalis*. In the descriptions which follow they will be cited as such.'—Quart. Journ. Geol. Soc., August, 1865, p. 281. According to this correction, all the figures in Plate xiv. B., except 10, 17, and 18, should belong to *E. antiquus*, although mostly from the Crag and some even from the Val d'Arno! The correction, moreover, is incompatible with the description and identification of every figure in Plate xiv. B., given in a subsequent part of the same memoir, and extracted above, according to which every figure in the plate, with the single exception of fig. 16, belongs to *E. meridionalis*. The fact is that the descriptions in Dr. F.'s memoir on Elephant were taken, in 1857, *from a proof copy of the plate, in which all the figures were designated E. antiquus*, but that in the plate as published in 1847, Dr. F. had actually corrected the designations of most of the figures.

The proof copy has been deposited in the Library of the Geological Department of the British Museum.—[Ed.]

The 'ridge-formula' in these specimens yields the same ciphers as are found to hold in the Italian specimens; and they agree in the other characters of a broad crown, with low ridges and thick plates of enamel.

Figs. 5 and 5 *a*.—*Elephas meridionalis*. A finely preserved entire specimen of the antepenultimate or first true molar, lower jaw, left side, composed of eight principal ridges, with front and back talons. The six anterior ridges are worn. The discs of the first three ridges are wide and open, but irregularly indented, with a tendency to mesial expansion, and surrounded by margins of thick enamel, which is vertically channelled externally, and slightly crimped; the posterior ridges show the apices of six or seven digitations; the interspaces filled with cement between the ridges are open, and the ridges well apart. The dimensions are:—

Length of crown, 5·3 in. Width in front, 1·6 in. Width behind, 2·3 in. Height of the seventh plate, 2·5 in.

One of the distinctive characters of the species, namely, the low height of the crown in reference to the breadth, is well exhibited. The specimen is dark-coloured and heavy, from ferruginous infiltration. It was discovered at Mundesley, and belonged to Mr. S. Woodward (Norwich Museum, No. 8).

Figs. 6 and 6 *a*.—*Elephas meridionalis*. Another left lower antepenultimate true molar of a larger individual, and more advanced in wear. The crown presents a front talon and eight ridges, all of them worn; the discs are wide and open, and the vallecular interspaces are also wide; the enamel edges thick, and in some of the plates disposed to slight crimping, with irregular angular expansion. The annular discs of the seventh ridge are of large size. This tooth bears the large anterior fang. It is a very characteristic specimen of *E. meridionalis*. The dimensions are:—

Length of crown, 5·5 in. Width of crown at second ridge, 2·2 in. Width of crown behind, 2·65 in. Height of crown at seventh ridge, barely worn, 2·0 in.

The specimen is hard, heavy, and dark-coloured, and is marked as having come from Mundesley (Norwich Museum, No. 7).

Figs. 7 and 7 *a*.—*Elephas meridionalis*. A fragment comprising the anterior two-thirds of the penultimate or second true molar of the lower jaw, right side. It includes seven worn ridges. The discs of wear are wide, and separated by broad bands of cement; the rings of the digitations are large; the plates of enamel are thick, with angular flexures and deep channelling on the outer surface, but free from crimping. The specimen is black and heavy, and bears patches of marine incrustation. The dimensions are:—

Extreme length, 5·2 in. Width of crown at second ridge, 2·3 in. Width of crown at seventh ridge, 2·9 in.

No note was taken of the height of the last ridge. The specimen is without fangs, and, although distinctly of *E. meridionalis*, the number of ridges to the entire crown is not shown. This also belonged to Mr. S. Woodward, and is now in the Norwich Museum (No. 13). It has all the mineral appearance of the Mundesley and Happisburgh beds.

Figs. 8 and 8 *a*.—*Elephas meridionalis*. The anterior portion of a lower right molar, comprising the remains of six well-worn ridges. It is figured to show the angular flexures that are sometimes seen when

the plates are ground down low. The side view, fig. 8 *a*, exhibits the thickness of the enamel. This specimen is too mutilated to fix its serial position with confidence. It is heavy and dark from iron impregnation, and corresponds with the fragments from Mundesley and Happisburgh Norwich Museum, No. 18.

Figs. 9 and 9 *a*.—*Elephas meridionalis*. The posterior two-thirds of the crown of a lower molar of the right side. It is inferred to be a penultimate, but without certainty, and may be the last true molar. The crown shows six well-worn discs and a posterior talon; there are no fangs; the enamel is very thick, with large rings to the digitations; the discs are somewhat angularly expanded, and separated by wide interspaces of cement. This is best shown by the side view, fig. 9 *a*. From being worn low down, the plates exhibit a greater tendency to crimping than is usual. The specimen is dark and heavy, and bears fresh patches of marine incrustation. It is one of Woodward's specimens, probably from the 'Oyster-bed' (Norwich Museum, No. 14). The dimensions are:—

Length, 5·3 in. Width of crown at second ridge, 3·2 in. Width of crown at fourth ridge, 3·1 in.

This is a characteristic fragment of *E. meridionalis*.

Figs. 10 and 10 *a*.—*Elephas meridionalis*. A specimen in Dr. Buckland's collection from the Val d'Arno. It is figured to demonstrate how exactly the English specimens agree with the Italian form, as may be seen by comparing figs. 8 and 9 with fig. 10. The fragment of lower jaw, although mutilated, shows well the long symphysis, and the gradual inclination of the diasteme into the beak.—B.M.

Figs. 11 and 11 *a*.—*Elephas meridionalis*. The posterior portion of a last lower molar of the right side, including six discs of wear and the back talon. The discs are broad, the interspaces of cement the same, and the enamel plates are very thick, with deep external vertical channelling, but without crimping. The specimen is black, heavy, and bears patches of marine incrustation, indicative of its having been procured from the 'Oyster-bed.' From Woodward's collection (Norwich Museum). The dimensions are:—

Length, 5·6 in. Width of crown in front, 2·8 in. Width of crown behind, 3·1 in.

This is also a characteristic specimen of *E. meridionalis*.

Figs. 12 and 12 *a*.—*Elephas meridionalis*. A very notable fragment of the posterior end of a last lower molar, comprising two discs of wear and a talon. The crown is ground down low, the interspaces of cement are very wide, and the annular discs of the digitations are so thick as to approach the character of the worn ridges of some of the Stegodons. The dimensions are:—

Length of the fragment, 2·7 in. Width of crown, 4·2 in.

A solitary digitation is situated at the outer side of one of the valleys. It bears the appearance of a Mundesley specimen.

Figs. 13 and 13 *a*.—*Elephas meridionalis*. A mutilated fragment of a very old upper molar, formerly in the collection of the late Dr. Mantell, and now in the collection of the British Museum (Old Palæontol. Cat. No. 7,456), comprising the remains of ten discs of wear, ground down nearly to their common base. The central discs exhibit a certain amount of open crimping. The specimen is also remarkable

for the breadth of the crown; it is understood to have been derived from the 'Oyster-bed' of Mundesley or Happisburgh. The dimensions are:—

Length of crown, 8·2 in. Width, 4·3 in.

I regard it as being of *E. meridionalis*.—H.F. 1857.

Figs. 14 and 14 *a*.—*Elephas meridionalis*. The crown of a fine last upper molar, left side, of a very old animal, and in an advanced stage of wear. There are nine ridges remaining, the first five of which are ground down into transverse discs; the posterior four exhibit rings that are not confluent. There is a talon behind enveloped by cement. In front of the first remaining disc there is a broad depressed surface of ivory, indicating the position of two or three worn-out discs in front. The discs are expanded, with a slight tendency to a crescentic bend, the cornua being bent forwards. The plates of enamel are very thick, and deeply channelled exteriorly, so that there is a spurious appearance of crimping on that surface; but the edges in contact with the cores of ivory are unplaited. The specimen in its mineral condition is black and heavy. It is understood to have belonged to Woodward (Norwich Museum, No. 10). The dimensions are:—

Length of crown, 9·2 in. Width of crown at second remaining ridge, 3·6 in.

The antero-posterior convexity of the grinding surface determines the tooth to be an upper molar. (Reproduced in Plate VIII. of vol. ii.)

Figs. 15 and 15 *a*.—*Elephas meridionalis*. A very remarkable fragment of upper molar, of enormous width. It is worn down close to the base, the grinding surface being somewhat convex from front to rear. The remains of seven discs of wear are visible. They are irregularly expanded, and the surrounding plates of enamel are thick and deeply channelled on the outer surface, but with only a very slight amount of crimping. The specimen is dark and heavy, and patched over with fresh marine incrustations. From Happisburgh (Norwich Museum, No. 13). The dimensions are:—

Length of the fragment, 5·4 in. Width of crown, 4·9 in.!

Figs. 16 and 16 *a*.—*Elephas antiquus*. 'The same plate, XIV. B., contains a representation, fig. 16, of an entire upper molar, comprising from sixteen to seventeen ridges within an extent of eleven inches. Only three of the anterior ridges are worn, the rest being intact. I now regard it as a molar of *E.* (*Euelephas*) *antiquus*, and not of *E. meridionalis*.'—H.F. 1857. (Norwich Museum.) Believed to be the *last* true molar, upper jaw, right side, from its triangular form and the way in which the ridges fall off in height very rapidly behind.

Height at fourth plate, 6·8 in. Height at posterior ridge, 2·8 in. Width of crown in front, 3·5 in.

Figs. 17 and 17 *a*.—*Elephas meridionalis*. A Val d'Arno lower molar of the same age, from Dr. Buckland's collection in the Oxford Museum, crown side. (Reproduced in Plate VIII. of vol. ii.)

Length of crown, 10· in. Width of crown, 3·4 in. Height of crown, 5· in.

Figs. 18 and 18 *a*.—*Elephas meridionalis*. 'The finest detached molar of this species that has come under my observation is a specimen which was discovered in the "Mammalliferous Crag" on the Thorpe Road, near Norwich, by Mr. Prestwich. The authority of so eminent and accurate a geologist is a sufficient guarantee for the locality and

the formation. It is now lodged in the Museum at Norwich, and is the specimen which first convinced me many years ago that the "Crag" yielded a species of Elephant entirely distinct from the Mammoth and from *E. antiquus*. It is represented, one-third of the natural size, by figs. 18 and 18 *a* of Pl. XIV. B., under the misnomer already explained, of *Elephas antiquus*, in the "Fauna Antiqua Sivalensis." It is the last true molar, lower jaw, right side, showing eleven principal ridges, an anterior talon, and a back talon limited to a single thick digitation. The first five ridges are slightly worn, the rest being intact. The fangs are broken off, but the definition of the anterior large fang is distinctly traceable. The cement over the surface generally has been decomposed or denuded, and is replaced by a crust of Crag matrix, of a very rusty appearance, filling the interspaces. The anterior talon thins off from the outside inwards, and is considerably narrower than the first ridge, of which the inner edge is broken. The apices of the ridges, from the second to the fifth inclusive, are all more or less fractured, and the digitations present very thick enamel. The sixth, seventh, and eighth ridges show each about four thick digitations; the ninth and tenth from four to five, converging; and the eleventh four digitations, the innermost of which is fractured. The definition of the base of the crown behind is a little damaged, but nothing is wanting. The dimensions are:—

Extreme length of crown, 11·25 in. Width of crown in front, 3·3 in. Width at fifth ridge, where the crown is broadest, 3·8 in. Extreme height of ridge, 4·8 in. Width of ninth ridge, 3·5 in. Height of ninth ridge, 4·6 in.

'From these dimensions it is apparent that, in a length of 11¼ inches, there are eleven ridges, with talons, and the seven ridges from the fourth to the tenth inclusive, measured along the inner wall of the crown, yield a length of fully 7 inches, being an average of one plate to an inch, and fully equal to the expansion of the ridges in the African Elephant, or in *E.* (*Loxodon*) *planifrons*. The terminal divisions of the ridges form stout irregular cylinders, as thick as the little finger, while in the Mammoth they are more slender and quill-shaped. The digital lobes of the ridges in *E. meridionalis* are so massive and distinct that they have occasionally been figured and described as being of *Mastodon*.'—H.F. 1857. (Reproduced in Plate VIII. of vol. ii.)

Plate XV.

Elephas insignis[1] (Falc. and Caut.). From the Sewalik hills. This is the most remarkable of all the Indian fossil Elephants. The cranium is as singular and grotesque in construction as that of the *Dinotherium giganteum*.

The cranium is seen to differ remarkably from that of *E. Ganesa* (Plates XXI. and XXII.) notwithstanding that the molars of the two species agree so closely. That of *E. insignis* is flattened at the top, elongated from side to side and singularly modified, so as to bear an analogy to the cranium of *Dinotherium giganteum*, while that of *E. Ganesa* does not differ much from the ordinary type of the Elephants. (See also Plates XLII., XLIII., XLIV., and XLV.)—Specimen is not in B.M.

[1] This is one of the forms included under *Mastodon Elephantoïdes* by Clift. See note 1, p. 461.

Plate XVI.

Fig 1.—*Elephas insignis.* Broken cranium, oblique antero-lateral view. Left orbit, &c., gone. This head is very cubical in form, is old, very concave in front and vertically; teeth broken. Interval between incisive sheaths deep. No tusks. A black specimen in Cautley's collection.—B.M.

Extreme length from occiput to surface of molars, 26· in. Depth of brow from occiput to upper margin of nasal opening, 5·5 in. Antero-posterior diameter of orbit, 5·5 in. Width of incisive sheaths at orbitary foramina, 11·4 in. From occipital to brow between middle of orbits, 17· in.

Fig. 2.—Lateral view of same skull, as shown in fig. 4, showing zygomatic arch.—B.M.

Fig. 3.—Posterior view of same skull, as in Plate XVII. figs. 1 and 2, showing occiput, occipital foramen, and condyles.—B.M.

Fig. 4.—Palate view of skull with last upper molars, from a specimen in H. F.'s collection, the same as shown in fig. 2.—B.M.

Length of palate to commencement of diastemal ridges, 10· in. Length of molar, 9·4 in. Number of plates 10, and a heel; probably two plates dropped out in front. Interval between molars in front, 1·9 in.; interval behind, 3· in. Height of pterygoids to palate, 10· in. Length of articulating surfaces for condyles of lower jaw, 5·4 in.; width, 2·6 in. Transverse diameter of right tusk, 3·5 in. Length of zygomatic arch, 14·3 in. Length of temporal fossa, 9· in.; width of temporal fossa from pterygoids to maxillary surface, 7·8 in. Antero-posterior diameter of orbits, 6·3 in.

Plate XVII.

Figs. 1 and 2.—*Elephas insignis.* Anterior and lateral view of cranium, same as represented in Plate XVI. fig. 3.—B.M.

Extreme length from occipital bulge to plane of molars, 23· in. From occipital bulge to broken tips of incisives, 24· in. Extreme width of occiput, 25·5 in. Width of brow at post-orbitaries, 24·4 in. Greatest contraction of brow between temporals, 18· in. From occipital plane to tip of nasals, 7·9 in. Width of naso-maxillary opening, 11·3 in. Depth of opening at wings, 3·2 in. Contraction of incisives at orbitary foramen, 12·2 in. Vertical height of orbit, 5·3 in. From occipital condyles to anterior end of palate, 22· in. From anterior margin of occipital to posterior surface of palate, 12· in. Length of palate to commencement of diasteme, 11·8 in. Height from sphenoid to tip of pterygoids, 9·8 in. Width of palate posteriorly between molars, 3·2 in. Width of palate in front, 2·8 in. From posterior surface of pterygoid to extremity of molar, 5·1 in. Height from occipital condyles to middle of brow between the orbits, 20·5 in. Distance between the outer margins of the occipital condyles, 7·2 in. Vertical diameter of occipital condyles, 2·8 in. Transverse diameter of occipital condyles (length of one), 3·8 in. Transverse diameter of occipital foramen, 2·9 in. Vertical diameter of occipital foramen, 2· in. From occiput to anterior margin of orbit, 15·6 in.

Figs. 3 and 4.—*E. insignis.* Anterior and lateral view of another cranium. Both zygomatic arches are missing, and the left side of the cranium is deficient. Shows the great length of the incisive sheaths.—B.M.

Plate XVIII.

Fig. 1.—*Elephas insignis.* Very young skull.—B.M.

Fig. 2.—*Elephas insignis.* Young skull with milk dentition.—B.M.

Fig. 3.—*Elephas insignis.* Skull of a middle-aged individual.—B.M.

Fig. 4.—*Elephas insignis.* Lower jaw with two (second and third) true molars. The specimen comprises only the right side, with symphysis

and beak. The left side has been restored in outline. The ascending ramus is broken off.—B.M.

Figs. 5 and 5 *a*.—*E. insignis.* Lower jaw, left side, with ascending ramus, but condyle broken off. Contains portion of last true molar. Fig. 5 *a* is a view of inner surface, with large opening for nutritious artery.—B.M.

Figs. 6 and 6 *a*.—*E. insignis.* Fragment of lower jaw, left side, of smaller individual, including ascending ramus and condyle.—B.M.

Fig. 7.—*Elephas planifrons.* Fragment of lower jaw with portions of two true molars.—B.M.

Plate XVIII. A.

Figs. 1 and 1 *a*.—*Elephas planifrons.* Last molar, lower (upper in MS.) jaw, left side. An enormous specimen in H. F.'s collection. Enamel very thick and denticles few. Eight plates. Is very like fig. 9 of Plate XI., and fig. 8 of Plate XIV.—B.M.

Length, 10·4 in.; width, 4·1 in.; height, 3·2 in.

Figs. 2 and 2 *a*.—*E. planifrons.* Last lower molar, right side. A very large specimen; enamel very thick; plates low; has a great fang in front; true type of large *E. planifrons.* This specimen is figured in a former plate (XI. 5).—B.M.

Length, 10·5 in. Width, 4·2 in. Height, 3·2 in. Height of plate where broken behind, 3·8 in.

Figs. 3 and 3 *a*.—*Elephas insignis.* Lower jaw containing on either side a molar with twelve ridges and a heel, the first six ridges worn; nine denticles to the seventh ridge; one large outer mentary foramen, none inside.—B.M.

Length of jaw, 20· in. Height at alveolus, 9· in. Length of molar, 12·2 in. Width of molar, 3·5 in.

Figs. 4 and 4 *a*.—*E. insignis.* Lower jaw, right side, with symphysis, but ascending ramus broken off. Contains two molars *in situ*; four ridges to first and seven to second; plates very deep. Edge of diasteme sharp; no mentary foramen shown.—B.M.

Extreme length of fragment of jaw, 18·2 in. Height at alveolus, 6·6 in. Greatest width, 6.6 in. Width of anterior molar, 3·4 in. Of last molar, 3·5 in.

Figs. 5 and 5 *a*.—*E. insignis.* Lower jaw, left side, containing last molar with eleven ridges and a heel of two points; the seven ridges in front are worn; plenty of cement. One large mentary foramen.—B.M.

Extreme length of fragment, 19· in. Height at alveolus, 7·4 in. Greatest width, 7·4 in. Length of molar, 11·3 in. Width in front, 4· in.

Figs. 6 and 6 *a*.—*Mastodon Sivalensis.* Lower jaw. Very indistinct specimen; teeth utterly worn out; enamel gone. One mentary foramen outside. Shows well the non-divergence of the rami behind.—B.M.

Height of jaw to alveolus, 8· in. Length of molar, 8·5 in. Interval between molars in front, 2·8 in. Interval between molars behind, 2·8 in.

Plate XIX.

Figs. 1 and 1 *a*.—*Elephas insignis.* Fragment of upper jaw containing first (*b*) and second milk molars, *in situ.* The second milk molar shows six ridges.—B.M.

Its length is 2·7 in., and greatest width, 1·6 in. It closely corresponds with a specimen in the Asiatic Society of Bengal. See *antea*, p. 109.

Figs. 2 and 2 *a*.—*E. insignis*. Third milk molar, upper jaw, *in situ*, in same young skull as fig. 1. Length, 4·8 in.—B.M.

Fig. 3.—*E. insignis*. Vertical section of third milk molar, *in situ*, in a very young cranium, which also contains first and second milk molars (fig. 1) and penultimate tusk on left side.—B.M.

Figs. 4 and 4 *a*.—*E. insignis*. Fragment of skull, showing palate, with two molars on either side; the first (third milk) molars well worn. The first true molar has seven ridges and a heel.—B.M.

Figs. 5 and 5 *a*.—*E. insignis*. Fragment of upper jaw with two molars. Very similar to specimen of *E. insignis* (Pl. XXIV. fig. 6). The molars are first and second true.—B.M.

Figs. 6 and 6 *a*.—*E. insignis*. Portion of fine head with two back molars. A small piece only of the front tooth remaining. The last tooth has eleven ridges and a heel and a great abundance of cement; the five front ridges are worn. The fossa between the tusk-sheaths is very deep and narrow, as in the other specimens of this species, an outward twist in the sheaths marking the curvature of the tusks.—B.M.

Length of the two teeth, 12·5 in. Length of last tooth only, 11·in.; width, 3·8 in. Interval between teeth in front, 1·2 in. Interval at niche behind, 4·7 in. Height of pterygoids to palate, 10·4 in.

Fig. 7.—*E. insignis*. Transverse section of young tusk *in situ*, in same cranium as figs. 1, 2, and 3.

Plate XIX. A.

Figs. 1 and 1 *a*.—*Elephas insignis*. Fragment of upper jaw with two molars; the front one much worn; the last has seven ridges. Very doubtful whether they are the second and third milk molars, or the third milk and first true molar; in all probability the latter.—B.M.

Length of front tooth, 3·6 in. Width, 1·8 in. Length of back tooth, 5·5 in. Width, 2·7 in.

Figs. 2 and 2 *a*.—*E. insignis*. Portion of small head, showing palate with two last molars on both sides. The front tooth has seven ridges, all worn but the last; the last has eleven ridges and a front and back heel, and its plates are very compressed, showing nine to ten denticles. —B.M.

Length of penultimate, 6·6 in. Width, 3·1 in. Length of last tooth, 11·3 in. Width, 3·4 in.

Figs. 3 and 3 *a*.—*E. insignis*. Portion of very large skull. In this splendid specimen some of the characteristic marks of the species are shown, and especially the enormous height of the pterygoids, which are 10·2 inches from the Vidian hole to the summit, wrap over the maxillaries, and run up forming a very strong crested ridge into the base of the orbit. Posteriorly, they form a flat disc-like surface, 3·8 inches broad. There are also the indications of very deep trunk fossa. The last left molar has nine ridges and a heel; a portion in front has dropped out. The corresponding tooth on right side is very imperfect.—B.M.

Length of last molar, 10·7 in. Width at fifth ridge, 4· in. Interval between teeth in front, 2·5 in. Interval between teeth behind, 4·5 in. Length of palate, from niche to commencement of diasteme, 12·3 in. Height of pterygoids, 10·2 in. Width of pterygoids outside, 9·5 in. Width of flattened surface of pterygoids, 3·8 in.

Figs. 4 and 4 *a*.—*E. insignis*. This, though mutilated, is a superb and characteristic specimen of the skull. It shows the concavity of the

brow, and the great depth of the trunk fossa. In this respect it resembles *Mastodon Sivalensis*, but there is no great divergency of the tusks, as in that species. The tusks are small and nearly cylindrical. The front tooth, very fine, has eight main ridges and a front and back heel; the back tooth entirely in germ, shows ten plates, the hindmost reversed, and the ridges like compressed plates.—B.M.

Length of anterior molar, left side, 9·7 in. Width at second ridge, 3·5 in. Interval in front between the molars, 2·6 in. Interval between the molars behind, 3·6 in. Length of palate from niche to diasteme, 9·7 in. Depth of trunk fossa, 8·2 in.!

Figs. 5 and 5 *a*.—*Elephas bombifrons*. Portion of skull showing palate with two teeth on either side. The front tooth has six ridges; the back one nine ridges and a front and back heel, only one ridge worn. The teeth have a great quantity of cement and the enamel is roughly fluted. These are characters of *E. bombifrons* rather than of *E. insignis*, as the figure is designated in the plate. The back tooth is very narrow behind, and so it is in *E. bombifrons*. The specimen resembles Pl. XXIX. fig. 2.—B.M.

Length of front tooth, left side, 7·2 in. Width, 3·6 in. Length of back molar, 11·1 in. Width, 4·2 in.

Plate XX.

Figs. 1 and 1 *a*.—*Elephas insignis*. Fragment of lower jaw with two milk molars (second and third).—B.M.

Figs. 2 and 2 *a*.—*E. insignis*. Fragment of lower jaw with milk molar (third). The tooth has seven ridges and a front talon.—B.M.

Figs. 3 and 3 *a*.—*E. insignis*. Fragment of lower jaw with second and third milk and first true molars. The first and last teeth are imperfect.—B.M.

Figs. 4 and 4 *a*.—*E. insignis*. Lower molar (second true?) with ten ridges, five front ridges worn; ten denticles in fourth ridge from back.—B.M.

Figs. 5 and 5 *a*.—*E. insignis*. Fragment of lower jaw including ascending ramus, with portion of back molar.—B.M.

Figs. 6 and 6 *a*.—*E. insignis*. Fragment of lower jaw containing second true molar with nine ridges and front and back heel; not at all worn.—B.M.

Figs. 7 and 7 *a*.—*E. insignis*. Fragment of lower jaw containing last true molar, with twelve or thirteen ridges, the five front ridges worn.

Figs. 8 and 8 *a*.—*E. insignis*. Fragment of lower jaw with last true molar containing about twelve ridges, of which only the three front ridges are worn; the greater part of the tooth still in germ. (Reproduced in Plate V. of vol. ii.)

Figs. 9 and 9 *a*.—*E. insignis*. Fragment of lower jaw with (second? true) molar; ten ridges, or nine ridges and a back talon. Fragment of another tooth in front. Specimen in Geol. Soc. Museum. For further description see Pl. XX. A. fig. 6.

Plate XX. A.

Figs. 1 and 1 *a*.—*Elephas Ganesa* (Falc. and Caut.). From the Sewalik hills. Lower jaw with first and second true molars. Proved to be so by fig. 2. A most remarkable jaw, very high in front and with

very divergent rami behind; diastemal edges very sharp; two outer mentary foramina on right side. The front tooth much worn; has five ridges and a heel; the last tooth has eight ridges. Nothing else like this in the collection.—B.M.

Extreme length of jaw, 18·5 in. Height at alveolus, 8·5 in. Width of jaw in front, 4· in. Width of jaw behind, 5·8 in.! Length of front tooth 5·1 in. Width, 2·7 in. Length of last tooth, 9·3 in. Width, 3·2 in.

Figs. 2 and 2 *a*.—*Elephas Ganesa*. Portion of lower jaw with left penultimate lower molar. The jaw in this specimen is also very high and narrow in front, and low behind. The tooth has seven ridges and a heel. Behind it is seen a portion of the last molar.—B.M.

Length of fragment, 14·5 in. Height at alveolus, 8·3 in. Height behind, 5·8 in. Width in front, 3·3 in. Width behind, 6·6 in. Length of molar, 9·2 in. Width at back, 3· in.

Fig. 3.—*Elephas insignis*. Fine specimen of lower jaw, including ascending ramus. Two outer mentary foramina. Second and third ? true molars.

Figs. 4 and 4 *a*.—*E. insignis*. Fragment of anterior portion of lower jaw. Is the only specimen that shows a beak entire to the tip. Is very like the large specimen containing a molar with great number of plates (*Vide* Plate XVIII. A. fig. 3).—B.M.

Figs. 5 and 5 *a*.—*E. insignis*. Fragment of lower jaw with last molar, imperfect. The latter has eight plates remaining; seven denticles to the second (distinct) ridge.

Length of fragment, 16· in. Length of eight plates of last molar, 8·1 in. Width in front, 3·1 in. Width behind, 3·5 in.

Fig. 6.—*E. insignis* ? Fragment of lower jaw with second (third ?) true molar. The plates show seven to eight points. This is the specimen described by Clift in the Geological Transactions. It is very like *E. insignis*. It is also represented in Plate XX. figs. 6 and 6 *a*.—Geol. Soc. Museum.

Length of fragment, 19· in. Height at alveolus, 6·6 in. Length of molar, 12· in. Width in front, 3·2 in. Width in the middle, 3·6 in. Length of fragment of anterior tooth, 4·2 in. Width, 2·5 in.

Figs. 7 and 7 *a*.—*E. insignis*. Fragment of lower jaw, right side, with first true molar nearly worn out, and six ridges of second molar. The plates are very high and there is much cement. The teeth are very broad in relation to the jaw, as compared with *E. Ganesa* in fig. 1. This is a beautiful specimen from Baker's collection.—B.M.

Length, 14·7 in. Height, 7·7 in. Width in front, 3·5 in. Width behind, 6·7 in. Length of front molar, 4·6 in. Width, 2·7 in. Length of back fragment, 5·3 in. Width, 3 in.

Plate XXI.

Elephas Ganesa (Falc. and Caut.). From the Sewalik hills, in Colonel Baker's collection. Large skull, with fragment of left incisive *in situ*, and corresponding fragment of right incisive detached. The incisive alveoli are remarkably elongated, as in *E. primigenius*. The plane of the incisives is continuous with that of the frontal, but with a tendency to obliquity forwards. The skull is very imperfect on right side. Pl. XXI. gives a front view one-fifth of the natural size, and Pl. XXII. figs. 1 and 2, give a lateral and palate view of the same skull. Compare with skull of *E. insignis*, Pl. XV.—B.M. The dimensions are as follows:—

Length of cranium from occipital protuberance to the end of incisive, left side (four feet exactly), 48· in. From occipital condyles to left side, 39· in. From occipital condyles to anterior border of molar alveolus, 25·5 in. Vertical height from condyles to sinciput, 24·5 in. Diameter across the occipital condyles, 9·2 in. Antero-posterior diameter of left condyle, 5·1 in. Transverse diameter of right condyle, 3·85 in. Transverse diameter of occipital foramen, 3·0 in. Antero-posterior diameter of occipital foramen, 3·1 in. From the surface occipital bulge plane to anterior entire margin of naso-maxillary sinus, 19·1 in. Semi-diameter of widest part of occipital (making total of occiput, 29·2 in.), 14·6 in. Semi-diameter (transverse) of naso-maxillary sinus (entire diameter restored, estimated 16· in.), 7·9 in. Interval between naso-maxillary sinus and post-orbital margin of frontal, 4·55 in. Mesial width across forehead from post-orbital process to inner margin of incisive, left side, 13·1 in. (Width of forehead at this part restored, 26·25 in.) From tip of post-orbitary process to surface of occipital, 17·75 in. From tip of incisives outside to post-orbitary process, 30·75 in. Length of incisive to margin of naso-maxillary sinus, 31· in. Depth of zygomatic fossa, 4·25 in. Estimated width of cranium between middle of zygomatic fossæ, 19·5 in. Height from lower margin of auditory foramen to the summit of sinciput, 18· in. Depth or height of cranium from the posterior margin of molar alveolus (back part of palate) to the summit of sinciput, 32· in. Depth from posterior and upper margin occipital foramen to posterior margin molar alveolus, 9·5 in. Height of the orbit, 8·78 in. Length of anterior portion of the palate, from anterior end of molar alveolus to tip of incisive, 16· in. Transverse diameter, left incisive at tip, 11·5 in. (Estimated width of both incisives at tip, 24· in.) Vertical diameter of left incisive at tip, 10·6 in. Vertical height of sub-orbitary foramen, left, 3·85 in. Width of incisive at contraction below sub-orbitary foramen, 10·75 in. Width of incisive sheath at sub-orbitary foramen, 7·5 in. (Estimated width of both incisive sheaths at sub-orbitary foramen, 21·5 in.) Interval between the posterior molars, anterior end (width of palate in front), 2·7 in. Interval behind, 3·25 in. Length of right molar (backmost), 11·9 in. Width of right molar in front, 4·05 in. Width of right molar behind, 5· in. Vertical height from posterior outer margin of molar alveolus to post-orbitary process, 21· in. Interval between outer surfaces of the molars at fifth ridge from front, 12·6 in. Antero-posterior diameter auditory foramen, 1·15 in. Transverse diameter auditory foramen, 1· in. Estimated height of occiput at restoration from lower surface of condyles to sinciput, 24·5 in. Length of left tusk outside the incisive sheath, measured along lower surface, 10 ft. 6 in. Length of left tusk, inside sheath, 2 ft. 3 in. to 2 ft. 4 in. Estimated total length, 12 ft. 9 in. Total length of head from occipital protuberance to tip of tusk, 4 ft. + 10 ft. 6 in. = 14½ ft. Length of right tusk, 10 ft. 8½ in. Interval between the tusks at emergence from incisive sheath, 6· in. Interval between the tusks at nearest approximation, at 3½ ft. from incisive, 3·5 in. Divergence at tips, 5 ft. 3½ in. as restored.' Height of versed sine of curve from tip to incisive border, right side, 23· in. Height of versed sine of curve, from tip to incisive border, left side, 23· in. Vertical diameter left tusk (14· in. from base) where greatest, 9· in. Transverse diameter, left tusk, at ditto, 7·9 in. Girth of left tusk, at ditto, 26· in.

PLATE XXII.

Fig. 1.—*Elephas Ganesa.* Lateral view of large skull figured in Pl. XXI.—B.M.

Fig. 2.—*E. Ganesa.* Palate view of same skull. The right incisive is seen in section. The posterior true molar is seen on either side of palate. It has ten plates and a heel behind, and a small talon in front; the hind heel has few denticles; the four front ridges are worn. The alveoli are parallel as in the Mammoth.—B.M.

Fig. 3.—*E. Ganesa.* Sketch showing restoration of skull, with tusks, of *E. Ganesa*, profile view, one-thirteenth of natural size.

PLATE XXIII.

Fig. 1.—*Elephas Ganesa.* Sketch showing restoration of skull, with

tusks, of *E. Ganesa*, oblique antero-lateral view, one-thirteenth of natural size.

Fig. 2.—Ditto, ditto, front view.

Plate XXIV.

Figs. 1 and 1 *a*.—*Elephas Ganesa*. Fragment of right upper jaw with first true molar. The tooth has six ridges and a heel; five ridges worn. From Baker's collection.

Length of molar, 5·1 in. Width in front at second ridge, 2·5 in. Width behind, 3· in.

Figs. 2 and 2 *a*.—*E. Ganesa*. Fragment of upper jaw with second? true molar presenting seven ridges.

Length of molar, 7·5 in. Width in front, 3·1 in. Width behind, 3·4 in.

Figs. 3 and 3 *a*.—*E. Ganesa*. Upper jaw, right side, with three ridges of first true molar, and entire penultimate. The latter has seven ridges and a heel; no cement; plates unworn. Closely resembles *E. insignis*.—B.M.

Length of penultimate molar, 9 in. Width, 4 in.

Figs. 4 and 4 *a*.—*E. Ganesa*. Fragment of last molar, upper jaw, right side. Fangs confluent; six ridges and a heel; discs of wear very large; the last ridge has seven denticles.—B.M.

Length of molar, 9·2 in. Width, 4·2 in.

Figs. 5 and 5 *a*.—*E. Ganesa*. Fragment of upper last? molar, right side, very large; shows six ridges, or five and a heel, very compressed; nine denticles on fourth ridge.—B.M.

Length of molar fragment, 7·4 in. Width, 4·3 in.

Figs. 6 and 6 *a*.—*Elephas insignis*. This is a very instructive specimen, consisting of the palate, with penultimate and antepenultimate true molars on both sides, from an animal of medium size. The antepenultimate has seven ridges, all worn but the last, and a small heel. The penultimate or second true molar is entirely in germ; it consists of eight main ridges and a front ridge, but has no heel. This is a characteristic type of true *E. insignis*, with the ridges very high and compressed. There are about ten points or denticles to the fifth ridge of the penultimate tooth, this being about the average; this tooth has no cement between the plates, only matrix. The front, or antepenultimate, tooth has plenty of cement. There are small tusks on both sides. Compare with Plate XIX. 5.

Length of antepenultimate, 6·8 in. Width, 3·2 in. Length of penultimate, 8·5 in. Width, 3·5 in.

Plate XXIV. A.

Figs. 1 and 1 *a*.—*Elephas Ganesa*. Fragment of skull with palate and back molars on both sides. This is a most remarkable specimen. I have called it *E. Ganesa* (H. F.), and it much resembles the molar of the big *Ganesa* specimen (Plate XXII. fig. 2) in form and in the compression of the ridges, but the ridges are few.[1]—B.M.

[1] Another specimen of Mr. Cunliffe's in Geological Society, not figured, is also very remarkable. Shows the palate with two last molars on both sides *in situ*. The front tooth has four plates, much worn and very crimped. The

Length of back molar, 9·7 in. Width, 3·8 in. Width of palate in front, 2· in. Width behind, 2·8 in.

Figs. 2, 2 *a*, and 2 *b*.—*Elephas insignis*. Small broken head. This is a very remarkable specimen. The teeth, although small, are assuredly the first and second true molars. The front tooth has six ridges and a heel; the penultimate has only seven ridges and a large heel, with a distinct talon in front; all the ridges of the front tooth worn; very little cement; plates deep. The tusks, if any, have dropped out; two large sub-orbitary foramina.—B.M.

Extreme length of skull, 18· in. Length of incisives, 15·8 in. Width between orbits measured to lachrymal tubercle, 7·8 in. Contraction of muzzle at suborbitaries, 11·9 in. Width of muzzle at tip, 9·2 in. Width between outer surfaces of maxillaries at the back molar (beginning), 8·4 in. Length from diasteme to tip of tusk-sheaths, 9·3 in. Depth from pterygoid to front, 14·7 in. Length of anterior molar, 4·9 in. Width, 2·7 in. Width of palate between front molars anteriorly, 1·5 in. Ditto behind, 2·2 in. Length of penultimate molar, 7·4 in. Width, 3· in.

Figs. 3 and 3 *a*.—*E. insignis*. Lower jaw, with first and second true molars. Five ridges remaining of front molar; other molar has twelve main ridges and a heel. Besides the characters shown in the figure, the diastemal portion is very much flattened in front of the anterior molar. This remarkable specimen is in the Museum of the College of Surgeons; the drawing is taken from a cast.

Extreme length of fragment of jaw, 24· in. Height to alveolus, 9· in. Width of jaw in front, 4·8 in. Width behind, 7·5 in. Length of ascending ramus, 12·8 in. Length of front molar, 5· in. Width, 3·5 in. Length of last molar, 11·5 in. Width, 4· in.

Figs. 4 and 4 *a*.—*Elephas Namadicus* (Falc. and Caut.). From the Nerbudda. Small head with two molars *in situ*; one worn, but the back one in germ; probably the first and second true molars. The right tusk is present; is very large for size of head; is nearly circular in outline, and diverges greatly in front. The tusk-sheaths are long, as in *E. Indicus* and *E. primigenius*. The brow-ridge, &c., are exactly as in the large head of *E. Namadicus* (Plate XII. A.). The space between the tusk-sheaths is very shallow, as in *E. planifrons*. Is probably a young male head.—B.M.

Extreme length from broken occiput to broken incisive, 29· in. From groove of brow to tip of nasals, 6·1 in. Across nasal opening, 12·5 in. Height of nasal opening at sides, 3·6 in. Width of muzzle (incisive sheaths) at orbital foramen, 13· in. From top of incisive sheath at fissure to diasteme, 9·8 in. Antero-posterior diameter of left orbit, 5·9 in. Transverse diameter of right tusk, 3·6 in.; vertical, nearly the same. Width of palate in front, 1·6 in. Width of palate behind, 2·7 in. Width of front tooth, 2·6 in.

PLATE XXV.

Figs. 1 and 1 *a*.—*Elephas Ganesa*. Lower jaw, with last lower molar. Shows two mentary foramina on either side; is very sharp in

last tooth has ten ridges, or nine and a large heel; only the two front ridges are worn; the tooth is very convex from back to front, and the ridges are very high and convex across, with a large quantity of cement. Looks very like (!) the *E. bombifrons* fragment, Pl. xxix. fig. 4.

Length of anterior molar, 4·5 in. Width, 4· in. Length of last molar (very much curved), 10·4 in. Greatest width, 3·9 in. Interval between front teeth, 1·9 in. Interval behind at niche of palate, 4·5 in.

front at diasteme, and high with an edge; ascending ramus is inclined forward and does not shelve out. Molar has seven or eight ridges remaining, but is imperfect in front; enamel very much crimped (*Vide* Plate XXV. A. fig. 2).—B.M.

Extreme length of jaw, 19·3 in. Height to alveolus, 8· in. Thickness in front, 4·1 in. Thickness behind, 6·3 in. Length of right molar, 8·9 in. Width at middle, 4·7 in.

Figs. 2 and 2 *a*.—*Elephas bombifrons* (Falc. and Caut.). From the Sewalik hills. Fragment of lower jaw, showing the united symphysis, parallel rami, and three large mentary foramina on outside. Only a fragment of last molar seen on both sides.—B.M.

Extreme length, 17·3 in. Height to alveolus, 7·8 in. Width of jaw in front, 3·6 in. Width of jaw behind, 6·1 in.

Figs. 3 and 3 *a*.—*E. bombifrons*. Magnificent specimen of lower jaw; fault in jaw; two large mentary foramina; beak very thick; right molar has nine ridges and a heel; enamel very thick; hardly any cement.—B.M.

Extreme length of jaw, 23·6 in. Height to alveolar margin, 9· in. Thickness in front, 4·2 in. Thickness behind, 8·3 in. Length of right molar, 12·9 in. Greatest width at fifth ridge, 4·4 in.

Figs. 4 and 4 *a*.—*Elephas insignis*. Lower jaw, partly distorted by pressure, and containing two molars on either side. The anterior (first true) molar is entire, though mutilated, and has seven ridges and a large heel. The back (second) molar is fragmentary.—B.M.

Extreme length of jaw, 15· in. Height to alveolus, 5·8 in. Thickness in front, 3·5 in. Thickness behind, 5·5 in. Length of front molar, left side, 6·5 in. Width at middle, 2·5 in.

Plate XXV. A.

Figs. 1 and 1 *a*.—*Elephas Ganesa* (Falc. and Caut.). Fragment of lower jaw, thick behind, with last lower molar, showing seven ridges and a heel, and great crimping, but no characteristic feature.—B.M.

Length of right molar, 8·8 in. Greatest width, 3·8 in.

Figs. 2 and 2 *a*.—*E. Ganesa*. Fragment of lower jaw, very old, with last molar much worn. Resembles Plate XXV. fig. 1.—B.M.

Height of jaw at alveolus, 7·8 in. Length of right molar, 10·2 in. Width, 4· in.

Figs. 3 and 3 *a*.—*E. Ganesa*. A dumpy, small-sized lower jaw, with imperfect molar; seven ridges remaining; the back ridges curved and much crimped.

Length of molar, 8·4 in. Width behind, 3·8 in. Width in front, 3·4 in.

Figs. 4 and 4 *a*.—*E. Ganesa*. This little lower jaw is very remarkable in being high and narrow; the ascending ramus is much bent forward. It contains three teeth, one in front worn out; a second with seven ridges and a heel, and a third in germ.—B.M.

Extreme length of jaw, 18·4 in. Height to alveolus, 6· in. Height at front tooth, 2·5 in. Height behind, 4· in. Length of ramus (antero-post.), 8·7 in. Length of front tooth, 2·5 in. Length of second tooth, 5·2 in.; width in front, 2· in.; width behind, 2·3 in.

Figs. 5 and 5 *a*.—*E. Ganesa*. Angle of lower jaw, left side, with portions of ascending and horizontal rami, and posterior five and a half ridges of last true molar.—B.M.

Length of fragment of molar, 7· in. Width, 3·9. in.

Figs. 6 and 6 *a*.—*E. Ganesa.* Portion of lower jaw, left side, with fragment of last true molar, showing anterior 9 ridges.

Length of tooth fragment, 9·3 in.; greatest width, 3·8 in.

Figs. 7 and 7 *a*.—*E. Ganesa.* Lower jaw, right side, with last molar. Shows the back part of the tooth, on to the anterior large fang.—B.M.

Length of fragment of jaw, 18· in. Length of fragment of tooth, 8·5 in.; width, 3·3 in.

PLATE XXVI.

Elephas bombifrons (Falc. and Caut.). From the Sewalik hills. Anterior view of large head.—B.M.

Extreme length from occipital to broken incisive, 34·2 in. Length from occipital to commencement of diasteme, 32·2 in. Occiput to tips of nasals, 16·2 in. Middle of naso-maxillary fissure, 14·7 in. Semi-diameter of brow at the post-orbitary, 12·2 in. Width of brow at post-orbitary, 24·4 in. Width of muzzle at contraction near orbitary foramen, 16·8 in. Width of inter-incisive fossa, 5·3 in.; depth of fossa below incisive sheaths, 6· in. Greatest contraction of brow, 13·3 in. Antero-posterior diameter of orbit, 6· in. Width of palate in front, 2· in. Width of palate at middle, 4·5 in. Width of palate behind, 4·6 in. Height of pterygoid, 11·2 in. Transverse diameter of left tusk, 3·3 in.

PLATE XXVII.

Elephas bombifrons (Falc. and Caut.). Very fine and perfect skull, anterior view. Four other views of same skull are given in Plate XXVIII. This head is very marked; it is convex from occiput to front and also across, and is very narrow at the temporal contraction. The bounding ridges sweep round by a bold curve into the post-orbitary processes, as in *E. meridionalis.* There is a deep furrow between the tusks. The nasal opening for the trunk is above the line (or nearly so) of the post-orbitary processes of the frontal bone. Above the infra-orbitary foramen on the right side there is another smaller opening. (On a proof copy of the plate this species is designated *Elephas intermedius*, or *Mastodon Elephantoïdes* of Clift.)—B.M.

Extreme length from occiput to broken incisives, 27· in. From occipital condyles to anterior border of alveolus of molar, 23·2 in. Vertical length of head from broken condyle to tip of occiput, 17·7 in. Greatest width of occiput, 25·5 in. Interval between auditory foramina, 21·5 in. From anterior margin occipital foramen to the posterior surface palate, 14· in. Length of palate from niche to the downward bend of tusk-sheaths, 12·5 in. Interval between outer surface of teeth, behind, 9·8 in. Int. between outer surf. teeth, in front, 9· in. Length of right molar, 10·2 in. Width in front of molar, 3·7 in. Width behind, 3·4 in. Interval between molars, in front, 1· in. Interval behind, extremely divergent, 4·2 in.; number of ridges 9 and a heel, 8 front worn. From occiput (middle) to tip of nasals, 13·8 in. Width of brow across post-orbitary processes, 22·4 in. Greatest contraction temporal fossa, 10·8 in. Transverse diameter nasal opening, 11·3 in. Depth of nasal opening at sides, 2·5 in. Interval between middle of orbits, 19·5 in. Vertical height of orbit, 4·6 in. Height from posterior surface palate to the middle of bulge of frontal, 23·5 in. From the anterior margin orbit to surface of occiput, 20· in. Width across incisive sheaths at base, 12·5 in.; interval between, about middle, 2·8 in. Depth of fossa between inc. sh., 4· in. Vertical diameter left tusk, 3·6 in. Transverse diameter of left tusk, 3·3 in.

PLATE XXVIII.

Fig. 1.—*Elephas bombifrons.* Lateral view of same skull, as figured in Plate XXVII.—B.M.

Fig. 2.—*E. bombifrons.* Palate view of same skull, showing sections of tusks, and last? true molar on either side, with 9 ridges and a heel;

the 8 front ridges worn. The interval between the molars in front is very narrow; behind they are extremely divergent.—B.M.

Fig. 3.—*E. bombifrons.* Antero-lateral view of same skull, with large infra-orbitary foramen.—B.M.

Fig. 4.—*E. bombifrons.* Posterior view of same skull, showing occiput, occipital foramen and condyles, and pterygoids.—B.M.

Fig. 5.—*E. bombifrons.* Detached specimen of occiput.—B.M.

Greatest width, 25·0 in. Vertical height, 17·2 in. Diameter across occipital condyles, 7·5 in. Transverse diameter of occipital foramen, 2·5 in. Vertical diameter of occipital foramen, 2·4 in.

Plate XXIX.

Fig. 1.—*Elephas bombifrons.* Broken cranium, palatal surface, with last true molar on either side, that on the right side presenting 8 ridges and a heel, and very fine.—B.M.

From anterior margin of occipital foramen to niche of palate, 14· in. Width of skull across occipital foramen, 8· in. Length of palate from niche to commencement of diasteme, 10·7 in. Width of palate between molars in front, 2· in. Width behind, 3· in. Length of right molar, 10· in. Width of other molar, 4· in. Width of incisive sheaths at muzzle, 13· in.

Figs. 2 and 2 *a.*—*E. bombifrons.* Broken cranium with last? true molar on either side of palate. The right molar has 8 ridges, of which the five anterior ones are much worn. The molars are approximated in front, and very divergent behind (*Vide* Plate XIX. A., 5).—B.M.

Figs. 3 and 3 *a.*—Second milk molar, upper jaw, left side of *Elephas insignis.* (Misnamed *E. bombifrons* on Plate.)

Figs. 4 and 4 *a.*—*E. bombifrons.* Upper last true molar, right side. This is a beautiful specimen, with a continuous transverse heel in front; 8 plates remaining; the points are very numerous; no mesial division. The tooth is convex across (See note to Plate XXIV. A., 1.)—B.M.

Length of fragment, 9· in. Width in front, 4· in.; width behind, 3·7 in.

Figs. 5 and 5 *a.*—*E. bombifrons.* Portion of upper jaw with a magnificent fragment of the last upper molar, right side, very large, discs very wide; shows 7 ridges and a heel. Very like the *Ganesa* specimen formerly in India House collection.—B.M.?

Length of fragment of molar, 10·4 in. Width in front, 3·8 in. Width behind, 3·8 in.

Figs. 6 and 6 *a.*—*E. bombifrons.* A magnificent palate specimen, with portion of cranium and last molar, right side, showing 9 ridges and a heel.—B.M.

Length of last molar, 10·9 in. Width in front, 3·8 in. Width behind, 3·8 in. Greatest width in middle, 4·3 in.

Plate XXIX. A.

Figs. 1 and 1 *a.*—*E. bombifrons.* A mutilated lower jaw, short and thick in its build, with what is probably the third milk molar, and having the first true molar appearing in germ behind. The milk molar shows 6 ridges and a heel. Baker's collection.—B.M.

Thickness of jaw in front, 2·8 in. Thickness of jaw behind, 5· in. Height at alveolus, 5· in. Length of anterior tooth, 4· in. Width, 2· in.

Figs. 2 and 2 *a.*—*E. bombifrons.* Fragment of lower jaw, right side, with what is certainly the first true molar, showing 7 ridges and a heel; all the

ridges worn but the last; the two first worn out; a long sloping diasteme; two outer mentary foramina.—B.M.

Height of jaw to alveolus, 7·in. Thickness in front, 3·4 in. Thickness behind, 6·in. Length of molar, 6·4 in. Width in front, 2·3 in. Width behind, 2·9 in.

Figs. 3 and 3 *a*.—*E. bombifrons*. Portion of lower jaw, left side, with one large outer mentary foramen, and penultimate true molar, showing 7 ridges and a large heel.—B.M.

Extreme length of fragment of jaw, 15·in. Height to alveolus, 7·3 in. Length of molar, 8·5 in. Width in front, 2·8 in. Width behind, 3·2 in.

Figs. 4 and 4 *a*.—*E. bombifrons*. Fine specimen of anterior portion of lower jaw, both rami with symphysis. Contains the penultimate true molar of either side, with 7 ridges and a heel. Shows also the commencement of the last tooth behind, and proves the tooth (fig. 2) to be the first true molar. Jaw is deficient on both sides behind the penultimate.—B.M.

Length of fragment, 14·3 in. Height to alveolus, 7·in. Thickness behind, 7·in. Interval between rami in front, 2·7 in. Interval behind, 3·3 in. Length of right molar, 8·in. Width in front, 2·9 in. Greatest width, 3·4 in.

Fig. 5.—*E. bombifrons ?* Fragment of molar, from lower jaw, right side, with four ridges.—B.M.

Length, 5·8 in. Width, 4·5 in.

Fig. 6.—*E. bombifrons ?* Fragment of molar with three ridges and a heel. 'Doubtful what figs. 5 and 6 are.'—H.F.

Length, 4·4 in. Width, 4·5 in.

Figs. 7 and 7 *a*.—*E. bombifrons*. Portion of lower jaw, with molar showing 7 ridges, counting the last; no heel; another tooth in germ behind; is apparently the first true molar, with the second, or penultimate, coming behind it.—B.M.

Length of anterior molar, 6·5 in. Width, 2·7 in.

Figs. 8 and 8 *a*.—*E. bombifrons*. Lower jaw, right side, of a small variety, but old. It is figured chiefly for its small size. The tooth is certainly the last molar; it is wide behind and very thick; the discs of wear are peculiar.—Specimen in Geol. Soc. Museum.

Height of jaw to alveolus, 7·5 in. Width behind, 6·5 in. Width in front, 4·5 in. Length of tooth, 7·8 in. Width behind, 3·in.

Plate XXIX. B.

Figs. 1 and 1 *a*.—*Elephas insignis*. Fragment of anterior half of second milk molar, of left lower jaw, with two ridges and a front talon.

Length of fragment, 1·7 in. Extreme width, 1·4 in. Height, 1·2 in.

Figs. 2 and 2 *a*.—*Elephas Ganesa*. Fragment of lower jaw, right side, with the third milk molar entire, presenting 7 ridges and a heel.

Length, 4·6 in. Width in front, 1·4 in. Width behind, 2·2 in.

Fig. 3.—*E. Ganesa*. Fragment of lower jaw, with three molars (second and third milk, and posterior 5 ridges of first true).

Figs. 4 and 4 *a*.—*E. Ganesa*. Fragment of lower jaw, right side, with fifth or penultimate molar, presenting 8 ridges.

Length, 7·25 in. Width in front, 3·1 in. Width behind, 2·9 in.

Figs. 5 and 5 *a*.—*Elephas bombifrons*. Fragment of lower jaw, right

side, showing third milk molar with 5 ridges and an anterior and posterior talon. The three anterior ridges are worn into a common disc.

Length, 3·6 in. Width in front, 1·4 in. Width behind, 1·8 in.

Figs. 6 and 6 *a*.—*Elephas bombifrons*. Fragment of lower jaw, right side, with the antepenultimate or first true molar, presenting 7 ridges and a heel.—B.M.

Length of molar, 5·9 in. Width in front, 2·1 in. Width at antepenultimate ridge, 2·7 in.

Figs. 7 and 7 *a*.—*E. bombifrons*. Last molar, lower jaw, left side, presenting 9 ridges and a heel; 3 front ridges abraded.—B.M.

Extreme length, 13·4 in. Extreme breadth of crown, 4·2 in. Breadth at posterior ridge, 3·2 in. Breadth of grinding surface, 3·2 in. Extreme height, 6·4 in.

Figs. 8 and 8 *a*.—*Elephas insignis*. Fragment of lower jaw, right side, with portions of penultimate and last true molars. Shows 4 ridges and a large posterior talon of penultimate, and 3 ridges and anterior talon of last molar. Two large outer mentary foramina.—B.M.

Length of grinding surface of penultimate, 6·3 in. Extreme breadth posteriorly, 3·7 in. Breadth across anterior ridge, 3·2 in.

Plate XXX.

Figs. 1 and 1 *a*.—*Elephas Cliftii*[1] (Falc. and Caut.). *Mastodon Elephantoïdes* of Clift. Palate, with third upper milk molar, and the three anterior ridges of the antepenultimate or first true molar.[2] The third milk molar is entire on one side, but worn down to the common base of ivory, so that the divisions of the crown have entirely disappeared, leaving no certain data for determining the ridge formula. Behind it the three anterior ridges of the antepenultimate true molar are seen *in situ*, the posterior half being broken off. The plane of the palate, on to the diastema, is very flat. The mesial line of division of the ridges in first true molar is not very distinct. This very interesting specimen was brought from Ava by Colonel Burney, and presented to the British Museum.

Extreme length of fragment, 10·6 in. Length of anterior tooth, 3·3 in. Width, 2· in. Length of second tooth, 3· in. Width, 3·4 in. Interval between teeth in front, 3·2 in.

Figs. 2 and 2 *a*.—*E. Cliftii*. This is the first or antepenultimate

[1] Mr. Clift, in his excellent memoir, includes the Ava fossil Proboscideans under two species, *Mastodon latidens* and *Mastodon Elephantoïdes*. In the 'Fauna Antiqua Sivalensis,' the former name is retained for the specimens of the *Tetralophodon* type, figured by Mr. Clift in the Geol. Trans., vol. ii. 2nd ser., Plate xxxvii. figs. 1 and 4; Plate xxxviii. fig. 1; and Plate xxxix. figs. 1, 2, and 3. Of the others, the palate specimen, Plate xxxvi. (*Mastodon latidens*, Clift), together with the detached molar, Plate xxxviii. fig. 6 (*Mastodon Elephantoïdes*, Clift), are referred to *E.* (*Stegodon*) *Cliftii*; and the lower jaw specimen, Plate xxxviii. fig. 2 (also *M. Elephantoïdes*, Clift), is referred to *E. Stegodon*) *insignis*. The specimens regarded by him as of his *M. Elephantoïdes* being here considered to belong more properly to the genus *Elephas*, it became necessary to resort to another specific designation. Hence the origin of *E.* (*Stegodon*) *insignis*.—H.F.

[2] In the Museum of the Royal College of Surgeons (Cat. No. 664) is another fine palate specimen of *E. Cliftii* with the penultimate and last true molars on both sides.

true molar, upper jaw, left side, entire, detached, and beautifully preserved. It has six ridges and a small hind talon. The tooth is nearly oblong. The enamel is somewhat fluted, and there is very little cement. There is very little convexity of the tooth across, and no distinct indication of the mesial dividing line. There are as many as eleven to twelve denticles or points. The tooth is compressed and angular in front, and the three front ridges are worn. This tooth is also represented by fig. 6 of Plate XXXIX. of Mr. Clift's Memoir (Geol. Trans., vol. ii., 2nd series). It is there described as *Mastodon Elephantoïdes*, under which title Mr. Clift included specimens referred by Dr. Falconer to two distinct forms.[1] Its elephantine affinities are indicated by the absence of a longitudinal line of division along the crown, and by the great number of points that enter into the composition of the ridges.—Cast in B.M.

Length, 6·1 in. Width in front, 3· in. Width behind, 3·3 in.

Figs. 3 and 3 *a*.—*Elephas Cliftii.* Superb palate specimen containing the penultimate true molar *in situ* on both sides. The tooth is proved to be the penultimate by its large dimensions, and by the circumstance that two or three ridges of another tooth (third true molar) is seen behind it.[2] The crown ridges are all more or less worn and partly damaged by fracture, but enough remains to show that the tooth was composed of six ridges and a hind talon. The palate is very flat, and the teeth on either side (in the erect position of the skull) slope upwards from without inwards. The teeth have very little cement. The diastemal ridges are wide apart. The right ridge shows the tusk-sheath; there is very little verticality of the tusk. The slope of grinding surface from without inwards is a mastodontoid character, which is very notably seen in Mr. W. Ewer's specimen of *M. Sivalensis* (Plate XXXIV. fig. 1). In the *Elephas insignis* the tendency of the grinding surface is to shelve upwards from the inside outwards, being the reverse of what holds in *E. Cliftii*.[3] This very important specimen is from Burmah, and is now in the Museum of the Geological Society. It is also represented by Clift in Plate XXXVI. of his Memoir in the Geological Transactions, vol. ii., 2nd series. The remaining portion of the upper jaw containing the last true molar is believed to be in the Museum of the Asiatic Society of Bengal (See *antea*, p. 114).

Extreme length of specimen, 19·in. Width of jaw at middle of molar, 8· in., doubled =16· in. Length of anterior molar, 8·2 in. Width, 4· in. Width of palate in front, 2·5 in. Width of palate between diastemal ridges, 4·8 in.

Figs. 4, 4 *a*, and 4 *b*.—*Elephas Cliftii.* A fragment of the penultimate molar, upper jaw, right side, with five ridges, shown also in section (*fig.* 4 *b*). Made out approximately to be *E. Cliftii.* Cement in moderate quantity.—B.M.

Length, 6·6 in. Width, 3·8 in.

Figs. 5 and 5 *a*.—*E. Cliftii.* Last true molar, lower jaw, left side, consisting of eight ridges and a talon. Five ridges are touched by wear, and the two anterior ridges are nearly worn out. The anterior large fang has been absorbed, but the portion of crown sustained by it

[1] See note 1, page 461.

[2] See note 2, page 461.

[3] In Col. Farquhar's specimen of the Indian Elephant, the plane of wear in the upper molars is as markedly from the inside outwards and upwards, as it is the reverse from outside inwards in *Mastodon Sivalensis*.

remains. The six posterior ridges have their fang elements confluent into a continuous plate or shell, thus maintaining the elephantine affinity indicated by the crown characters. The crown is very flat; the points are large and few in number, and there is no very distinct mesial dividing line, but little cement. This magnificent specimen was brought from Burmah by Col. Burney, and presented by him to the British Museum (See *antea*, p. 114, and Plate V. of vol. ii.).

Length, 12·7 in. Width at middle, 4·5 in.

Figs. 6 and 6 *a*.—*Mastodon latidens* [1] (Clift). Fragment of lower jaw, left side, with last or third true molar. This is one of the most enormous specimens ever seen, the greatest girth over the molar being no less than 27·5 inches. There is one mental foramen; no appearance of tusk. The molar has five ridges and a double heel; the points are very large, and the discs of wear very broad; the mesial line of division is distinct; there is no cement. The plane of wear in front shelves from the inside out. There is a very similar specimen in the Museum of the Asiatic Society of Bengal (See *antea*, p. 120).

Extreme length of fragment, 16·2 in. Height of jaw at anterior end of alveolus, 10·2 in. Greatest thickness, 6·8 in. Length of molar, 11·3 in. Greatest width, 4·5 in.

Plate XXXI.

Figs. 1 and 1 *a*.—*Mastodon latidens*. Upper milk molar.—B.M.

Length, 2·7 in. Width, 2·4 in.

Figs. 2 and 2 *a*.—*M. latidens*. Upper milk molar (third?).—Cast in B.M.

Length, 3·8 in. Width, 2·6 in.

Figs. 3 and 3 *a*.—*M. latidens*. Fragment of upper jaw, right side, with two molars (third milk and first true?).—B.M.

Length of posterior molar, 5·6 in. Width, 2·9 in. Length of anterior molar, 3·7 in. Width, 2·6 in.

Figs. 4 and 4 *a*.—*M. latidens*. Portion of palate, with two upper molars left side.—B.M.

Length of anterior tooth, 3·9 in. Width, 2·8 in. Length of posterior tooth, 4·2 in. Width, 3·4 in.

Figs. 5 and 5 *a*.—*M. latidens*. Fragment of upper molar.—Cast in B.M.

Length of fragment, 3·4 in. Width, 4·2 in.

Figs. 6 and 6 *a*.—*M. latidens*. Upper true molar, very perfect.—B.M.

Length, 8·5 in. Width, 4·5 in.

Figs. 7 and 7 *a*.—*M. latidens*. Fragment of lower molar with fang (See *antea*, p. 121).—B.M.

Length, 5· in. Width, 3·3 in. Length of crown fang, 5·3 in.

Figs. 8 and 8 *a*.—*M. latidens*. Lower molar well worn (See *antea*, p. 121).—B.M.

Length, 6·4 in. Width, 3·3 in. Height of crown fang, 6·4 in.

Mastodon latidens, like the *M. longirostris* of Eppelsheim, presents a Dinotherian type, in so far as the crowns of the molar teeth are concerned; and in this respect it contrasts with *M. Sivalensis* and *M. Arvernensis*, in which the molars have a hippopotamoid type. In *M. latidens* the crown is broad, the mammillæ are thicker in proportion

[1] See note 1, page 461.

to their height; the ridges are less elevated, and consist of a greater number of coronal points, and the valleys are more open and transverse (or interrupted only by an insignificant number of warty tubercles) than in *M. Sivalensis* (See *antea*, p. 121).

Figs. 9 and 9 *a*.—*Mastodon Perimensis* (Falc. and Caut.). From Perim Island. Portion of upper jaw, right side, with molar, presenting characters similar to those of *M. Sivalensis* and *M. Arvernensis* (See *antea*, pp. 117, 122).—B.M.

Length, 6·3 in. Width, 3·3 in.

Figs. 10 and 10 *a*.—*M. Perimensis*. Portion of lower jaw, left side, with penultimate and last true molars. Presented by Miss Pepper to B.M.

Length of anterior molar, 4·8 in. Width, 2·6 in. Length of fragment of posterior molar, 2·1 in. Width, 2·8 in.

Figs. 11 and 11 *a*.—Fragment of lower jaw, with molar.

Length of tooth, 8·4 in. Width, 3·5 in.

PLATE XXXII.

Mastodon Sivalensis (Falc. and Caut.). From the Sewalik hills; anterior view. Three other views of same cranium in Plate XXXIII. The brow is a little crushed between the temporals. The left tusk-sheath is present, the right is withered; there is distortion of the tusk-sheaths in consequence. There is an enormous and peculiar projection of the lips of incisive anterior end of naso-maxillary fissure, so as to project over the trunk, or inter-incisive fossa. This fossa is very deep, enormously so. The depressions for the condyles of the lower jaw are very vaulted. There are two infra-orbitary foramina on the right side. The grinders are very much worn. On the left side there would be five ridges, with a very complicated heel-series. Posteriorly, the teeth show well the peculiar characters of *Mastodon Sivalensis*.—B.M. (Reproduced in Plate X.)

Extreme length from occipital bulge to tips of incisives, 28·3 in. Width of occiput, 22·4 in. Height of occiput from plane of condyles, 19·0 in. Interval between outer edge of condyles, 6·6 in. Vertical diameter of occipital condyle, 4·0 in. Transverse diameter occipital condyle, 2·7 in. Width of base of occiput, 21·0 in. Transverse diameter occip. foram. 2·9 in. Vertical diameter occip. for. 2·5 in. From occiput to broken tips of nasals, 14·0 in. From occiput to anterior margin of orbit, 21·0 in. From anterior margin nasal opening to the tips of the incisive, 14·0 in. Width of brow between post-orbitary processes, 25·5 in. Width at contraction between temporals, 11·6 in. Width of naso-maxillary (trunk) opening, 12·0 in. Depth of naso-max. op., lateral, 3·0 in. Vertical diameter orbits (nearly circular), 4·3 in. Transverse diameter orbits, 4·3 in. Interval between orbitary processes of one orbit, 2·7 in. Width of forehead at anterior margin of orbit, 20·6 in. Contraction of muzzle at orbitary foramen, 13·0 in. Depth of trunk fossa below brow, 9·8 in. Greatest interval between zygomatic arches, 22·0 in. From base of zygomatic to top of occiput, 20·5 in. Depth of anterior orbitary process of maxillary, 4·5 in. Height of skull from palate to top of occiput, 25·0 in. From posterior surface condyles to posterior surface palate, 16·0 in. From pterygoid processes to anterior margin of palate, 12·2 in. Height of pterygoid, 10·3 in. Distance from molar to posterior surface of pterygoid, 4·2 in. Width of pterygoid above, 6·0 in. Width of pterygoid below, 7·5 in. Width of fissure (between pterygoids), 2·3 in. Length of palate at middle, 9·6 in. Width of palate between molars in front, 2·8 in. Width of palate between molars behind, 2·6 in. Length of left molar, 7·8 in. Width of left molar in front, 3·2 in. Width of left molar behind, 3·3 in. Length of articulating condyles for lower jaw, 4·8 in. Greatest width of condyles for lower jaw, 3·0 in.

Plate XXXIII.

Fig. 1.—*Mastodon Sivalensis.* Lateral view of same skull as is figured in Plate XXXII. Shows temporal fossa and left zygomatic arch entire.—B.M.

Fig. 2.—Palate view, showing palate, one molar on each side, both zygomatic arches entire, occipital condyles, &c. Same cranium as fig. 1. —B.M.

Fig. 3.—Occipital view of same cranium, showing occipital condyles and foramen, pterygoids, &c.—B.M.

Fig. 4.—Lateral view of another cranium of *M. Sivalensis*, with lower jaw *in situ*. The left zygomatic arch is broken away.—B.M.

Plate XXXIV.

Fig. 1.—*Mastodon Sivalensis.* Portion of skull showing palate with two molars on either side, the posterior molar on right side imperfect. In this specimen there are two large orbitary foramina and there is only a tusk on the right side; the left tusk-sheath is withered. The tusk-sheaths are very divergent, with an enormous deep trough between, and there is great concavity of the brow, as in *E. insignis.* The teeth diverge anteriorly, as in *Mastodon Ohioticus*, but in a less degree. The molars are excessively like Smith's specimen of the last molar upper jaw, right side, of *Mastodon Arvernensis* (Plate XXXVI. fig. 8). The slope of grinding surface from without inwards is very notably seen (see Plate XXX. fig. 3). The anterior molar of both sides is worn, but shows four ridges with a heel, the ridges so advanced in wear as to exhibit the characteristic alternating discs of wear, so remarkable in this species. The last molar is perfect, except the heel ridge, on the left side. The front ridge is barely touched by wear, while the four back ridges are intact. The drawing does not show the characters very perfectly. The front ridge has two confluent ridges on the inside and two on the outside, to the inner of which the intermediate pillar is attached, joining on with the innermost large point of the third ridge. This third ridge shows but one thick point on the inner division and two on the outer, with the intermediate pillar connecting the outer division of the third with the inner division of the fourth ridge, and so with the last ridge. This diagonal connection of the posterior surface of the outer division with the anterior surface of the inner points of the next following ridge cause in wear the alternate-like discs of detrition, which characterize the teeth of *Mastodon Sivalensis.* The same kind of arrangement holds in Smith's specimen of *Mastodon Arvernensis.* The points in *M. Sivalensis* are very high and obtuse, and the apex of the ridges is high as compared with the specimen in Mr. W. Ewer's collection. (See also *antea*, p. 117.)

Length of two molars, right side, 9·2 in. Length of front molar, left side, 4·7 in.; width, 2·8 in. Length of last left molar minus heel, 6·4 in.; width, 3·0 in. Interval between teeth in front, 3·4 in.; interval between teeth behind, 2·7 in. Height of enamel crown, 2·3 in. Height of inner mammilla of second ridge, 1·8 in. Length of palate from niche to diasteme, 9·0 in. Antero-posterior diameter right tusk, 3·0 in.; transverse, 2·7 in. Width of base of muzzle at orbitary foramen, 14·0 in. Interval between the middle of the orbits, 19·2 in. Antero-posterior diameter or height of left orbit, 4·8 in.

Figs. 2 and 2 *a.*—*M. Sivalensis.* Fragment of upper jaw with molar presenting six ridges, with same characters as in fig. 1. The two anterior ridges only are touched by wear. The tooth is now cut into sections. —B.M.

Figs. 3 and 3 *a*.—*M. Sivalensis*. Fragment of lower jaw with portion of molar, four ridges and part of a fifth.—B.M.

Extreme length, 5·4 in. Breadth in front, 2·5 in.

Figs. 4 and 4 *a*.—*M. Sivalensis*. Fragment of lower jaw, with three ridges of a molar.—B.M.

Figs. 5 and 5 *a*.—*M. Sivalensis*. Fragment of molar.—B.M.

Plate XXXV.

Figs. 1 and 1 *a*.—*Mastodon Sivalensis*. Fine specimen of lower jaw, with one molar on either side. A portion of the right ramus deficient, but restored in the drawing. The teeth show well the alternating discs of wear characteristic of the species, and two outer mentary foramina.—B.M.

Fig. 2.—*Mastodon longirostris* (Kaup), from Eppelsheim; lower jaw in outline, profile view; from a cast.

Figs. 3 and 3 *a*.—*Mastodon Andium* (Cuv.). Perfect lower jaw of an adult with two last molars *in situ*, from Buenos Ayres. The anterior tooth confirms what is shown by the Canterbury specimen (Plate XL. fig. 15) respecting the penultimate. It is in an advanced stage of wear, but exhibits distinctly the discs of three ridges. The crown is nearly rectangular in form; the dimensions being 5·1 in. in length, 2·85 in. of width in front, and 3· in. behind. The posterior tooth, which is the last or third true molar, has the crown composed of four principal ridges, and a complex sub-triangular heel of several points. The three anterior ridges are partly worn and exhibit well the characteristic complex trefoil discs of wear. The two posterior ridges are intact, and the sinuous hollows between them show the very considerable layer of cement which is present in a greater quantity in this than in any other species of true *Mastodon*. The dimensions of this tooth are about 8 in. in length by 3·5 in. of width in front, whence it narrows gradually towards the posterior end.—B.M. (Reproduced in Pl. VIII. fig. 3.)

Fig. 4.—*Mastodon Ohioticus* (Blumb.), from North America. Fine specimen of lower jaw with two last molars, viewed from above. The anterior or penultimate tooth consists of three ridges separated by transverse uninterrupted valleys; all the ridges are slightly affected by wear. The posterior tooth consists of four main ridges and a subordinate talon ridge; all untouched by wear.—B.M.

Fig. 5.—*M. Ohioticus*. Profile view of same jaw. One large and one small mentary foramen.—B.M.

Figs. 6 and 6 *a*.—*Dinotherium Indicum* (Falc.). Superb fragment of lower jaw, left side, with molars, brought from Perim Island by Miss Pepper. The specimen contains nearly the whole of the adult series of five molars *in situ*. The contour of the body of the jaw is shown in the most perfect state of preservation, the fossil having fortunately been mineralized by means of a very hard siliceo-ferruginous infiltration. But it has evidently been long rolled about on the sea-beach as a boulder, so that the crowns of the whole series of molars have been hammered off nearly level with the alveolar margin of the jaw; the surface of the fossil is jet black, and almost all of the matrix has been cleared away, probably by the long-continued action of the sea, which has given it a semi-vitreous polish. Patches of recent marine shells are also found on the surface. The symphysis of the jaw is broken off about $2\frac{1}{2}$ in. in front of the anterior premolar, and the bone is truncated

behind exactly opposite the point where the coronoid margin of the ramus begins to rise up, the fracture passing through the middle of the last molar, the anterior ridge of which is visible *in situ* in the jaw. A detailed description of the points of distinction between this fossil and the *Dinotherium giganteum* of Kaup is given in the memoir on Perim Island fossils (See page 404, and Pl. XXXIII. fig. 5).—B.M.

Length of fragment, 17· in. Length of four front teeth, 13·5 in. Length of first premolar, 3·5 in. Width of first premolar behind, 2·2 in. Length of second premolar, 2·9 in. Width of second premolar behind, 2·6 in. Length of third or first true molar, 4· in. Width behind, 2·8 in. Length of fourth tooth (second true molar), 3·9 in. Width, 3·5 in. Depth of jaw to alveolar margin at the second premolar, 9·2 in. Depth at third tooth or first true molar, 8·7 in. Width of jaw at second premolar, 5·1 in. Width at middle of fourth tooth, 6·4 in. Distance between the upper margin of mentary foramen and alveolus of first premolar, 3·6 in. Distance from inferior margin to first premolar, 4·75 in.

PLATE XXXVI.

Figs. 1 and 1 *a*.—*Mastodon Sivalensis.* Fragment of upper jaw with (second) milk molar.

Length of tooth, 2·6 in.

Figs. 2 and 2 *a*.—*M. Sivalensis.* Fragment of upper jaw with two milk molars. (Second and third).—B.M.

Length of anterior tooth, 2·6 in. Width, 1·8 in. Length of posterior tooth, 4· in. Width, 2·3 in.

Figs. 3 and 3 *a*.—*M. Sivalensis.* Portion of upper jaw, with fragment of molar. (First or second true m.).—B.M.

Length of fragment of crown, 4· in. Width, 2·9 in.

Figs. 4 and 4 *a*.—*M. Sivalensis.* Fragment of upper jaw, with second? true molar, presenting five ridges, with alternately disposed crown mammillæ.—B.M.

Length of molar, 5·6 in. Width, 2·9 in.

Figs. 5 and 5 *a*.—*M. Sivalensis.* Fragment of upper jaw, with last? true molar. Five ridges and a hind talon.—B.M.

Length of molar, 6·5 in. Width, 2·9 in.

Figs. 6 and 6 *a*.—*Mastodon Sivalensis.* Last molar, upper jaw, left side in plan and profile. It has six ridges and a hind talon, and in this respect it differs from both *M. Arvernensis* and *M. longirostris*, but it most resembles the former in so far as the alternate disposition of the crown mammillæ is concerned. The complexity of pattern is even greater than in the English Crag Mastodon.—Cast in B.M. (Reproduced in Pl. IX. figs. 1 and 2.)

Length of tooth, 7·8 in. Width, 3·3 in.

Figs. 7 and 7 *a*.—*Mastodon Arvernensis*, or the English Crag Mastodon. Left upper jaw of a calf, with the last milk molar beautifully preserved *in situ*, and the remains of the empty alveolus of the penultimate milk molar in front of it. The crown is composed of four ridges with a front and hind talon, and a well-pronounced basal 'bourrelet.' The three anterior divisions are more or less worn, especially along the inner side; the last ridge is nearly intact. The ridges are connected by one or two stout conical mammillæ, interrupting their transverse continuity, and alternating with the divisions of the main ridges. The vertical furrowing of the enamel at *b* and *c*,

presenting the appearance of a reeded column or of a number of cords pressed close together, is remarkable. This character is not present in the corresponding young molars of *Mastodon longirostris*, Pl. XL. fig. 6, in which the enamel is irregularly wrinkled but never presents the symmetrical fluting observed in the 'Crag' Mastodon. This difference indeed is sufficient to distinguish the young teeth of the two species. Discovered in the 'Crag' at Portwick by Mr. Wigham, and figured by Lyell, 'Manual of Elementary Geology,' 5th ed. 1855, p. 166, fig. 133.

Length of tooth, 2·9 in. Width anteriorly, 1·7 in. Width posteriorly, 1·8 in. Width of grinding surface, 1·2 in.

Figs. 8 and 8 *a*.—*Mastodon Arvernensis*. Last true molar, upper jaw, right side, composed of five ridges with an anterior talon, and a strong back talon. The crown is obscurely divided longitudinally by a shallow cleft along its axis. Deep clefts or valleys intervene between the ridges; but the valleys, instead of being transverse, are interrupted in the middle by one or more large accessory conical mammillæ, interposed between the ridges and alternating with the outer and inner divisions. This is the famous Whittingham tooth forming the frontispiece of Mr. W. Smith's 'Strata Identified,' and of which a woodcut (reversed) is given in Owen's 'British Fossil Mammalia,' p. 276.

Length of tooth, 7· in. Width, 2·9 in.

Figs. 9 and 9 *a*.—*Mastodon Arvernensis*. Another specimen of last true molar, upper jaw, left side. This is Captain Alexander's specimen dredged up between Southwold and Easton, and of which there is a cast in the Museum of the Geological Society. The specimen is very black with a sandy matrix and no vertical pillaring. The crown consists of five ridges and a heel ridge of four points. The anterior edge is broken. The enamel is very thick. There are three sub-alternate mammillæ in the first valley. The second and third ridges are very closely approximated, with but one intermediate mammilla. The third and fourth are wide apart with three mammillæ in the valley. The fourth and fifth have but one intermediate mammilla.

Figs. 10 and 10 *a*.—*Mastodon longirostris*. Antepenultimate true molar, upper jaw. From Eppelsheim. Cast in B.M.

Length, 4·5 in. Width, 2·5 in.

Figs. 11 and 11 *a*.—*Mastodon longirostris*. Penultimate true molar from Eppelsheim. Cast in B.M.

Extreme length, 5·4 in. Width anteriorly, 3· in. Width posteriorly, 3·3 in.

Figs. 12 and 12 *a*.—*Mastodon longirostris*. Last true molar, upper jaw. Shows five ridges and a talon. The crown is broader, and the mammillæ thicker in proportion to their height, than in *M. Arvernensis*. The ridges also are less elevated, and consist of a greater number of coronal points. The valleys are either entirely open and transverse, or interrupted only by an insignificant number of warty tubercles. From Eppelsheim. Cast in B.M.

Length, 9· in. Width, 3·8 in.

Figs. 13 and 13 *a*.—*Mastodon longirostris*. Last true molar, upper jaw, presenting some characters as fig. 12. From Eppelsheim. Cast in B.M.

Length, 6·8 in. Width, 2·9 in.

PLATE XXXVII.

Figs. 1 and 1 *a*.—*Mastodon Sivalensis*. Portion of lower jaw, right side, with first (*x*) and second milk molars.—B.M.

Length of fragment of jaw, 4·7 in. Greatest breadth, 2·6 in. Height opposite posterior border of second milk molar, 2·1 in. Length of first molar, ·6 in. Greatest breadth, ·4 in. Length of second milk molar, 1·8 in. Greatest width, 1·1 in.

Figs. 2 and 2 *a*.—*M. Sivalensis*. Portion of lower jaw, left side, with symphysis and two outer mentary foramina, and containing first (*x*) and second milk molars.—B.M.

Length of symphysis (oblique), 2· in. From first molar to anterior margin of symphysis, 2·5 in. Length of anterior or first molar, ·4 in. Greatest width, ·4 in. Length of second molar, 1·9 in. Greatest width, 1·2 in. Length of fragment of jaw, 6·6 in. Greatest breadth, 2·1 in. Height at anterior margin of second molar, 2·3 in.

Figs. 3 and 3 *a*.—*M. Sivalensis*. Portion of lower jaw, right side, with symphysis and third milk, and fragment of fourth, or first true, molars.[1]—B.M.

Length of fragment, 12· in. Length of symphysis (ant. post.), 4·4 in. Greatest width of fragment, 3·8 in. Height at posterior margin of third molar, 4·2 in. Length of third molar, 3·5 in. Greatest width, 2· in.

Figs. 4 and 4 *a*.—*M. Sivalensis*. Fragment of lower jaw, left side, with first ? true molar, imperfect anteriorly.—B.M.

Breadth of jaw, 5·7 in. Height, 5·4 in. Length of tooth (imperfect), 8· in. Width, 3·2 in.

Figs. 5 and 5 *a*.—*M. Sivalensis*. Fragment of lower jaw with portion of true molar well worn. Shows well the alternate discs of wear.

Figs. 6 and 6 *a*.—*M. Sivalensis*. Fragment of lower jaw, left side, with penultimate ? true molar, imperfect behind.[2]—B.M.

Width of fragment of jaw, 6·1 in. Height, 6·1 in. Length of fragment of tooth, 6· in. Width, 3·2 in.

Figs. 7 and 7 *a*.—*M. Sivalensis*. Fragment of lower jaw, right side, with last true molar, much worn, and imperfect in front.—B.M.

Length of molar (imperfect), 8·4 in. Width, 3· in.

[1] In the Museum of the Royal College of Surgeons (Cat. No. 669) is a beautiful specimen of ramus of right lower jaw of a young *M. Sivalensis*, with the third milk and first true molar. The anterior tooth is a little broken and worn out in front; it shows six discs of wear and a large talon ridge. The talon and 4 last ridges are quite distinct, the 5th and 6th are worn out, and probably an anterior talon was included with front ridge. This would make 6 ridges and a back and front talon, or 8 in all. The tooth has little cement, the ridges are low, and there is great plaiting of the enamel plates in wear. Length of tooth, 4·2 in.; width at last big ridge, 2·4 in.; width at fourth ridge, 2·05 in.; width at second ridge, 1·9 in. The posterior tooth has 5 emerged ridges with a talon in front, extending only from the outside, half way across, but thick. The rest of the tooth is concealed. The two front ridges and talon are slightly touched by wear. Width of tooth at first ridge, 2·2 in. Width at second, 2·3 in. Length from middle of first ridge to middle of fifth (excluding talon), 3· in. The third ridge shows 11 little points. No. 670 is the left side of the same jaw with corresponding teeth. The mentary foramen is very much in advance of the fourth tooth, and placed low.—H.F.

[2] Another specimen of left lower jaw of *M. Sivalensis*, with what is probably the penultimate true molar, is in the Museum of the Royal College of Surgeons (Cat. No. 690). It has four transverse ridges and a heel of two points, not 5 ridges as stated in catalogue. Length of tooth, 5·9 in.; width at first ridge, 2·4 in.; at fourth, 2·5 in.—H.F.

Figs. 8 and 8 *a*.—*M. Sivalensis*. Fragment of lower jaw, left side, containing a very perfect specimen of the last lower molar. The alternate disposition of the mammillæ of the crown is finely exhibited. Cast in B.M.

Length of tooth, 8·8 in. Width, 2·9 in.

Figs. 9 and 9 *a*.—*Mastodon Arvernensis*. Fragment showing posterior half of the last inferior true molar. The mammillæ form two alternate rows as in *M. Sivalensis*, each ridge being composed of a pair of points. From a cast in Museum of Geological Society.

Length of fragment of tooth, 5·6 in. Width, 3.8 in.

PLATE XXXVIII.

Mastodon Perimensis (Falc. and Caut.), from Perim Island. Front view of skull. Other views of same skull are given in Plate XXXIX. figs. 1, 2, and 3.

This cranium is in many respects singularly perfect, although it has suffered from a crushing force, which has forced in the temples, so as to have contracted to a few inches the inter-temporal portion of the forehead. The ascending ramus of the lower jaw on either side is *in situ* with the coronoid process and condyle, and, what is more remarkable, the greater part of the hyoid bone lies upon the sphenoid. The atlas also was found attached to the condyles. The teeth are completely hammered down to the margin of the alveoli. The most remarkable character of all about this head is the low height of the pterygoid processes of the sphenoid, which are very little higher than the condyles, and the comparatively little elevation of the condyles above the palate. The interval between the plane of the lower surface of the condyles and that of the palate is only 5 inches, the height of the occiput being 22 inches. This is very much as in the North American Mastodon, and even more so, so that the plane of the grinder does not differ much from that of the condyles, thus showing a tendency in the direction of *Dinotherium* and the Trilophodon *Mastodon Ohioticus*. The pterygoids rise with a sharp posterior border, and do not spread out into a flap over the posterior border of the maxillary. They are not rugous as *M. Ohioticus*, nor are they so far (proportionally) extended behind. There are two large palatine foramina near the end of the molar. The molars (allowing perhaps for some distortion from pressure) run parallel, and do not at any rate diverge in the remarkable way exhibited by *M. Ohioticus*; perhaps they are less divergent even than in *M. Sivalensis*. The palate looks long. On either side are two molars, the penultimate and last true. The tusks exhibit an oval outline on section. Both zygomatic arches are entire. Presented by Captain Fulljames to B.M.

Extreme length from occiput to broken incisives, 27· in. From posterior surface of occipital condyles to commencement of diasteme, 25·5 in. Extreme width of occiput, 20· in. Height of occiput from condyles, 22·2 in. From occiput to broken tips of nasals, 13· in. From tips of incisives (anterior end of nasal opening) to commencement of diasteme, 14·5 in. Width of nasal opening (approximate) 9·8 in.; antero-post. diameter of nasal opening, 4·3 in. Estimated width of brow at post. orbitaries, 19· in. Width of brow at middle of orbits, 15· in. Width of inter-incisive fossa, 2·2 in. Depth of inter-incisive fossa, 3·4 in. Contraction of muzzle at orbitary foramen, 11·6 in. Vertical diameter of right orbit, 4·8 in. From the auditory foramen to the anterior border of the orbit, 16·5. Transverse

diameter of left tusk, 2·9 in. Vertical diameter of left tusk (approximate), 4· in. Width across the condyles, 7·6 in. Antero-post. diameter of condyle, 3·5 in.; transverse diameter of condyle, 2·5 in. Vertical height of condyle, 2·6 in. Antero-post. diameter of occipital foramen, 2·8 in.; transverse diameter of occipital foramen, 2·9 in. From anterior border of occipital foramen to niche of palate, 10·9 in. From niche of palate to beginning of diastema, 12·7 in. Height of the pterygoids above the body of the sphenoid, 5·5 or 6· in. Width of outer surface of pterygoids, 7·7 in. Length of two broken molars (surface), 11·7 in. Length of anterior or penultimate, 4·4 in.; width, 3·1 in. Length of back molar, 7·4 in.; width, 3·2 in. Width of palate between anterior molars, 1·6 in. Width of palate, behind, 3·5 in.

PLATE XXXIX.

Fig. 1.—*Mastodon Perimensis.* Lateral view of same skull as figured in Plate XXXVIII., described above.—B.M.

Fig. 2.—*Mastodon Perimensis.* Palate view of same skull.—B.M.

Fig. 3.—*Mastodon Perimensis.* Occipital view of same skull.—B.M.

Figs. 4, 5, and 6.—*Mastodon Sivalensis.* Fragment of small black head, three different views. The specimen is very perfect in form, without crushing, so far as it goes. The plane of the occiput meets that of the frontal in a slightly rounded manner. The ligamentary depression is placed about the middle of the occiput, and is not deeply marked, consisting of a dividing crest, separating two diverging pits, having a heart-shaped outline. The occiput is slightly convex across and from base to top. The condyles do not project backwards as in *M. Perimensis.* The posterior boundary of the temple (edge of occiput) is inclined to be sharp. There is no tendency to occipital bosses as in Elephant. The occiput in some respects resembles that of *M. Ohioticus.* There is a very obtuse convexity or boss on the middle of the forehead between the temples.—B.M.

Greatest width of occiput (the half doubled) 22· in. Height of occiput from surface of condyles, 17· in. Contraction of brow between the temporals, 11·8 in. Interval across the condyles, 7·1 in. Antero-post. diameter of left condyle, 4·1 in. Transverse diameter of left condyle, 2·5 in.

Fig. 7.—*Mastodon Sivalensis.* Fragment of upper jaw with two molars, broken end of incisives, and anterior portion of zygoma. From a cast in B.M.

PLATE XL.

Figs. 1 and 1 *a*.—*Mastodon latidens.* Second? upper milk molar with two ridges.—B.M.

Length, 1·9 in.; width, 1·4 in.[1]

Figs. 2 and 2 *a*.—*M. latidens.* Third? upper milk molar with four ridges.—B.M.

Length, 3· in.; width, 1·8 in.

[1] In the Museum of the Royal College of Surgeons is the left side of the upper jaw of a young *Mastodon latidens* containing the first and second milk molars. The anterior tooth is about 1· in. long, and ·8 in. wide, and has two ridges with a heel. The main ridge is transverse; the anterior one is an obtuse cusp. The tooth is oval, the sharp end being in front. The second milk molar is 2· in. long by about 1·5 in. wide. It has three main transverse ridges and a small bourrelet ridge in front, and a heel ridge behind. It expands very widely in the direction of the orbit. A vertical section shows something like the enamel of another small tooth, ½ inch long.—H.F.

Figs. 3 and 3 *a*.—*M. latidens*. Upper molar (first true?) with four ridges and back and front heel.—B.M.

Length, 4· in.; width, 2·3 in.

Figs. 4 and 4 *a*.—*M. Perimensis*. Fragment of upper molar showing two ridges and part of a third. The valleys are transverse, but are interrupted in the middle by an accessory lobule in front of and behind each ridge, and the outer termination of each ridge is bounded by a large mammilla, exactly as in *Mastodon latidens*.—B.M.

Figs. 5 and 5 *a*. *M. Perimensis*. Fragment of lower jaw with portion of true molar, presenting a similar arrangement of mammillæ to that noted under fig. 4. (See also *antea*, pp. 117 and 122.)

Length of fragment of molar, 5·4 in.; width, 3·2 in.

Figs. 6 and 6 *a*.—*Mastodon longirostris*. Fragment of right lower jaw of young calf showing the series of three milk molars *in situ*. The third milk molar is nearly intact; the four ridges of which it is composed are seen to be transverse, compressed, and composed of a number of little points; the valleys are open, with the exception of a tubercle in the first, and two or three minute tubercles in the last valley, which in no way interrupt their transverse continuity. The back talon forms a low transverse free ridgelet as in the *Mastodon latidens* of India. The enamel is irregularly wrinkled, but exhibits no vertical fluting, as in *M. Arvernensis* (See Plate XXXVI. fig. 7). The original specimen from Eppelsheim was formerly in the Earl of Enniskillen's collection, but is now in B.M. It is also figured by Kaup ('Oss. Foss. de Darmstadt,' Plate XX. fig. 2.)

Length of first tooth, 1·2 in. Width, ·9 in. Length of second tooth, 1·8 in. Width, 1·5 in. Length of third tooth, 2·6 in. Width, 2·1 in.

Figs. 7 and 7 *a*.—*Mastodon angustidens*. Third? milk molar upper jaw, the crown consisting of three transverse ridges and an accessory talon of two tubercles. A single tubercle juts out into each of the hollows between the ridges alternately with the principal points, accounting for the trefoil-shaped discs, which the worn teeth present in this species, so different from the lozenge-shaped discs of *M. Ohioticus*. This specimen is from Mr. Edward Charlesworth's collection, but there is no history as to its origin.—B.M.

Length of tooth, 2·8 in. Width, 1·6 in.

Figs. 8 and 8 *a*.—*M. angustidens*. Antepenultimate or first true molar, having the crown divided into three distinct ridges, with a small back talon.

Length, 4·6 in. Width, 2·6 in.

Figs. 9 and 9 *a*.—*M. angustidens*. Penultimate molar of upper jaw, consisting of three ridges and a talon appendage of two tubercles behind. The two anterior ridges are affected by wear; the last is almost intact. The intervals, wide and deep, have only a single mammilla connecting the ridges, about the middle. The crown is very simple, each ridge consisting of two pairs of points. The tooth has a strong impression in front, is narrow in front and widens behind. The drawing is taken from a cast in B.M. The original specimen was what Cuvier commenced his account of the species, and it is figured by him in 'Divers Mastodontes,' p. 255, and Plate I. fig. 4. The dimen-

sions correspond exactly with those of Lartet's Gers specimen, viz.: Length, 4·5 in. Width in front, 2·1 in. Width behind, 2·6 in.

Figs. 10 and 10 *a*.—*Mastodon Andium*.[1] Fragment of upper true molar. Presented by Lord Shelburne. Shows four ridges and portion of a fifth.—B.M.

Length, 6· in. Width, 3·5 in.

Fig. 11.—*M. Andium*. Fragment of upper molar, with discs of three ridges much worn.—B.M.

Length, 5·2 in. Width, 3·2 in.

Figs. 12 and 12 *a*.—*M. Andium*. Last upper true molar with four ridges and a complicated heel.—B.M.

Length, 6·8 in. Width, 3·5 in.

Figs. 13 and 13 *a*.—*M. Andium*. Fragment of left lower jaw, with second and third milk molars *in situ*. The specimen is broken at the symphysis and coronoid process. From the relative size of the jaw and the development of the teeth, the animal corresponded to a sucking Indian elephant of about two years of age. The second milk grinder is fully protruded, but had barely come into use, the two front ridges being but slightly abraded. The third is in the state of an intact germ, and although fully formed, it had not penetrated the gum when the animal died. These teeth are both three-ridged, with a subordinate crest in front, and a small bi-tubercular talon behind. They are exactly alike in form, narrow in front, but broader backwards. The ridges, as in *M. angustidens*, consist of two pairs of principal points, which instead of being nearly simple, as in the latter species, are subdivided into a vast number of superficial warty tubercles, which jut into the valleys, forming a bridge or connection between the contiguous ridges, and interrupting the transverse continuity of the valleys. In this respect they more resemble the young teeth of *M. longirostris*. Specimen from Buenos Ayres in B.M. (Reproduced in Plate VIII. fig. 1.)

Length of fragment of jaw, 7·6 in. Breadth, 2·7 in. Height, 2·9 in. Length of second milk molar, 2·6 in. Width, 1·4 in. Length of third milk molar, 3·5 in. Width, 1·7 in.

Figs. 14 and 14 *a*.—*Mastodon Andium*. Fragment of lower jaw with last true molar, exhibiting four ridges and a complicated heel. The three anterior ridges are touched by wear.

Length of tooth, 7·8 in. Width, 3·2 in.

Figs. 15 and 15 *a*.—*M. Andium*. Greater portion of lower jaw, left side, with the first and second true molars (penultimate and antepenultimate) *in situ*, showing also the empty alveolus of the last true grinder and of the third milk tooth. The ternary number holds in the ridges, there being three collines in each tooth, with an aggregate nest of tubercles in the intervals. There are no remains of cement. The anterior tooth is somewhat worn, the discs taking the form of a quadrifoil. This specimen is from Chili, and was presented to the Museum at Canterbury by General Miller; there is a cast of it in the

[1] Memorandum of head of *M. Andium* in British Museum, not figured. Shows palate with molars.

Length of the anterior or inter-maxillary portion of palate, 15· in. Interval between teeth in front, 4·4 in.; interval between teeth behind, 3·4 in. Length of last molar, left side, 8·75 in.; width in front, 3·75 in.; width behind, 3·25 in.

British Museum. It is of an age intermediate between the specimens figured in Plate XXXV. 3, and Plate XL. 13. It is very valuable, and is believed to be at present unique in Europe. (Reproduced in Plate VIII. fig. 2.)

Length of fragment of jaw, 15· in. Breadth, 4·3 in. Height, 4·1 in. Length of first molar, 4· in. Breadth, 2·6 in. Length of second molar, 5·5 in. Breadth, 2·7 in.

Fig. 16.—*Mastodon Ohioticus.* Fragment of upper jaw, with three ridges and fangs of last upper molar, also empty cavity in jaw for fang of fourth ridge.—B.M.

Length, 5·1 in. Width, 4· in. Height of crown and fang, 7· in.

Fig. 16 *a.*—*M. Ohioticus.* Last true molar, upper jaw, with four main ridges and a heel; the first ridge only very slightly touched by wear. In *Mastodon Ohioticus* the upper teeth are distinctly cleft lengthwise into two divisions, each division being indistinctly composed of a pair of confluent points. The plane of the tooth is oblique, sloping from the outside, which is higher, to the inside, which is lower, and this relation continues during the wear, the inside being the most worn. The inner division, both anteriorly and posteriorly, throws off the decurrent talon crests, but in the first two milk teeth the inner division is smaller than the outer. Precisely the reverse is seen in lower jaw, the inner ridge being the highest and remaining so during detrition, while the outer is the lowest but least complex.—B.M.

Length, 7·3 in. Width, 4· in.

Plate XLI.

Tusks of Proboscidea.[1] Fragments and sections.

Figs. 1 and 1 *a.*—Twisted fragment.—B.M.

Length measured along great curvature, 40· in. Direct length or chord of curvature, 28· in. Circumference at proximal end, 12·7 in. Circumference at distal end, 13·2 in.

Fig. 2.—B.M.

Length, 56· in. Circumference at proximal end, 13·5 in.

Figs. 3 and 3 *a.*—B.M.

Length of fragment, 12·2 in. Circumference, 12·2 in. Greatest diameter, 3·7 in.

Figs. 4, 4 *a*, and 4 *b.*—B.M.

Length of fragment, 12·7 in. Greatest diameter, 7·7 in. Smallest diameter, 5· in.

Fig. 5.—B.M.

Greatest diameter, 9·8 in. Smallest diameter, 7·2 in.

Figs. 6 and 6 *a.*—Fragment of tusk in socket.

Length of socket, 13·5 in. Circumference of tusk, 6·2 in. Breadth of incisive alveolar margin, 6·2 in.

Figs. 7 and 7 *a.*—B.M.

Length, 68· in. Circumference at proximal end, 11· in.

Figs. 8 and 8 *a.*—B.M.

Length of fragment, 33· in. Circumference at smaller end, 16·5 in.

[1] There is no evidence of any attempt made by Dr. Falconer to determine the species to which any of these specimens belonged. All the specimens figured in the plate (with the exception of figs. 6 and 25) are collected in one place in the British Museum.

Figs. 9 and 9 *a*.—B.M.

Length, 11·6 in. Great diameter, 7·4 in. Small diameter, 5·9 in.

Figs. 10 and 10 *a*.—B.M.

Length of fragment, 12·4 in. Circumference, 16·6 in.

Figs. 11 and 11 *a*.—B.M.

Length of fragment, 14·7 in. Circumference at upper end, 21·2 in.

Figs. 12 and 12 *a*.—B.M.

Length along great curvature, 23· in. Greatest circumference, 12· in. Least circumference at tip, 4·8 in.

Figs. 13 and 13 *a*.—B.M.

Length, 20· in. Greatest circumference, 17· in.

Figs. 14 and 14 *a*.—B.M.

Length of fragment, 12·7 in. Great diameter of section, 5· in. Smaller diameter of section, 4·4 in.

Figs. 15 and 15 *a*.—B.M.

Length of fragment, 11·8 in. Greatest circumference, 11·5 in.

Figs. 16 and 16 *a*.—B.M.

Length of fragment, 7·8 in. Greatest circumference, 9·2 in.

Figs. 17 and 17 *a*.—B.M.

Length, 9·6 in. Greatest circumference, 7·8 in.

Figs. 18 and 18 *a*.—B.M.

Length, 10·3 in. Greatest circumference, 13·5 in.

Figs. 19 and 19 *a*.—B.M.

Length, 9·2 in. Circumference, 13·5 in.

Figs. 20 and 20 *a*.—B.M.

Length, 9· in. Circumference, 19·2 in.

Figs. 21 and 21 *a*.—Matrix with fragments of two tusks.—B.M.

Length of fragment, 22·5 in. Proximal end of left tusk, 5·1 by 4·1 in. Proximal end of right tusk, 5·1 by 4·8 in. Distal end of left tusk, 3·9 by 3· in. Distal end of right tusk, 4·3 by 4·2 in.

Figs. 22 and 22 *a*.—B.M.

Length, 14·5 in. Circumference, 13·5 in.

Figs. 23 and 23 *a*.—Fragment of jaw with alveolus of left tusk, and part of right tusk.—B.M.

Length of fragment of jaw, 13·7 in. Between external alveolar margins of incisors, 20·4 in. Great diameter of tusk, 6·7 in. Lesser diameter of tusk, 5·7 in.

Fig. 24.—B.M.

Length of fragment of upper jaw, 14·2 in.

Figs. 25 and 25 *a*.—Unequal fragments of two tusks joined together.

Length of great fragment, 10·2 in. Length of small fragment, 7·8 in. Circumference of great fragment, 16· in. Circumference of smaller fragment, 15·3 in.

PLATES XLII. and XLIII.

Anterior views of skulls of Proboscidea, restored, in outline.

PLATES XLIV. and XLV.

Profile views of skulls of Proboscidea, restored, in outline.

In these four plates[1] the skulls are classified, and are arranged in a series forming a transition from one to the other, as follows: [2]

I. TRILOPHODONTES.

1.—*Dinotherium giganteum* (after Kaup), with two large deflected tusks in lower jaw.

2.—*Dinotherium Indicum* (not figured).

3.—*Mastodon Tapiroïdes* (not figured).

4.—*Mastodon Ohioticus*[3] (copied from American Phil. Transactions, 1838, vol. viii. Plate III., adding a tusk to lower jaw).

5.—*Mastodon angustidens* (De Blainville's Ostéographie, Plate III.).

6.—*Mastodon Andium* (British Museum specimen).

II. TETRALOPHODONTES.

7.—*Mastodon Perimensis* (Indian collection, see Plates XXXVIII. and XXXIX.).

8.—*Mastodon Sivalensis* (Indian collection, see Plates XXXII., XXXIII., and XXXIV.).

9.—*Mastodon Arvernensis* (after Nesti, imperfect).

10.—*Mastodon longirostris* (after Kaup, imperfect).

11.—*Mastodon latidens* (not figured).

III. STEGODONTES.

12.—*Elephas Cliftii*, Clift's specimen, very imperfect.

13.—*Elephas bombifrons* (Indian collection, see Plate XXVII.).

14.—*Elephas Ganesa* (Col. Baker's huge cranium in British Museum, see Plate XXI.).

[1] Reproduced in vol. ii.

[2] *Note by Dr. F. in* 1857.—'The views which we entertain were fully elucidated in 1847 in the four plates of outline-heads, from Plate xlii. to xlv. of the "Fauna Antiqua Sivalensis," where a synopsis is given of all the species, fossil and recent, then known. The forms included under the nominal species of *M. angustidens* of Cuvier, are there ranged as four distinct species, viz.:—*M.* (*Triloph.*) *angustidens*, *M.* (*Triloph.*) *Andium*, *M.* (*Tetraloph.*) *longirostris*, and *M.* (*Tetraloph.*) *Arvernensis*. The only change which subsequent investigation on fresh materials has led us to make is to transfer *M. Andium* from the subgenus *Trilophodon* into that of *Tetralophodon*.' In 1863, however, Dr. F. expressed the opinion that *M. Andium* would, after all, prove to belong to the Trilophodon group (Memoir on *Elephas Columbi* in vol. ii.).

[3] *Memorandum by Dr. F. on broken head of Mastodon Ohioticus.*—'The occiput forms a vertical plane, the condyles being right under the base, and not projecting behind. The crista galli is not very large, and the ligamentary depression is shallow with divergent lobes, broad above and narrow below. The pterygoid alæ of the sphenoid, instead of overlapping the maxillaries by a conical lamina, rise up in a rough rugous stem, and are much behind the last teeth, which are very divergent. The pterygoids are low, but not more so than (if so much as) in *M. Perimensis*.

'Extreme length of cranium from occiput to incisive tips, 34·2 in. Width of brow at post orbitaries, 19·6 in. Width at contraction of muzzle near sub-orbitary foramen, 15·2 in. Width of nasal opening, 5·4 in. Antero-posterior diameter of orbit, 5·6 in. From anterior margin of orbit to occipital plane, 22· in. Width across occipital condyles, 8·7 in. From anterior margin of occipital hole to niche of palate, 11·5 in. Height of the pterygoid alae from Vidian hole, 8·5 in. From back of molar to edge of pterygoid, 4·2 in. Length of molar with four ridges and a heel, 6·7 in. Width of palate in front of penultimate teeth, 3·9 in. Width behind, 3·9 in. Length of palate from niche to diasteme, 13· in. Interval between diastemal ridges at commencement, 4·5 in. Interval between tips of divergence, 5·6 in.!'

15 *a*.—*Elephas insignis*, old (Indian collection, see Plate XV.).
15 *b*.—*Elephas insignis* (Indian collection, see Plate XVII., fig 1).
15 *c*.—*Elephas insignis*, young (Indian collection, see Plate XVIII. fig. 3).

IV. Loxodontes.

16.—*Elephas planifrons* (Indian collection, see Plate IX.).
17.—*Elephas Africanus* (recent head).
18.—*Elephas priscus* (not figured).

V. Elasmodontes.[1]

19.—*Elephas meridionalis*[2] (after Nesti).
20 *a*.—*Elephas Hysudricus* (Indian collection, see Plate IV.).
20 *b*.—*Elephas Hysudricus*, young (Indian collection, see Plate VI.).
21.—*Elephas antiquus*[3] (not figured).
22.—*Elephas Namadicus* (Indian collection, see Plate XII. A.).
23 *a*.—*Elephas Indicus*[4] (Dauntela var.).

[1] The designation of *Elasmodus* having been preoccupied by Sir Philip Egerton for a series of fossil fish, Dr. F., in 1857 substituted the term *Euclephas* for *Elasmodon*.

[2] This is erroneously designated *E. antiquus* in the plate (see note, page 443). The illustration is taken from Nesti's figure. The skull is nearly perfect in the frontal and occipital regions, condyles, maxillaries, and molars, but imperfect in the facial portion, the border of the nasal opening being broken, together with the terminal portion of the incisive alveoli and zygomatic arches. The line formed by the posterior border of the vertex is transverse, the fossa being overarched by a produced fold of the vertex.

[3] *Elephas meridionalis* in Plate (see note, page 443).

[4] Comparison between *Mukna* and *Dauntela* varieties of *Elephas Indicus*.

	Mukna (big head). Inches	Dauntela. Inches
Extreme length of cranium	40·5	41·5
Width between zygomatics	29·5	29·75
Ditto post-orbitary processes	22·5	24·0
Length from niche of occiput to tips of nasals	22·0	21·0
Greatest width of occiput	31·0	30·5
Width of nasal opening	14·0	15·0
Depth of ditto	5·75	5·75
Width of tusk-sheaths	14·25	17·5
Narrow width of brow	13·5	13·25
Depth of orbit	6·5	6·5
Height from condyles to occiput	22·25	22·0
Across condyles	8·75	8·5
From condyles to tip of tusk-sheath	33·0	35·25
From ditto to anterior margin of molar alveolus	22·5	22·25
From anterior margin occipital hole to posterior border palate	12·0	11·5
Length of palate	8·0	9·5
Depth of head from condyles to frontal surface at middle, opposite nasal opening	23·5	23·5
Height from diastemal surface to bulge of occiput	30·75	31·25
Length of condyloid surface	6·5	6·25
From ear-hole to top of occiput	19·0	19·0
Length of anterior tooth, upper jaw	8·37	dropped out
Width ditto ditto	3·5	
Number of plates, about ten		

23 *b*.—*Elephas Indicus* (Mukna var.).
23 *c*.—*Elephas Indicus* (young).
24.—*Elephas primigenius* (Fischer's drawing).

PLATE XLVI.[1]

Figs. 1 to 11.—Atlases of Proboscidea.

Figs. 1, 1 *a*, and 1 *b*.

Between extreme points of transverse processes, 16·7 in. Between extreme points of anterior articular surfaces, 8·5 in. Height, 9·3 in. Length of inferior arch, under surface, 2·8 in.

Figs 2, 2 *a*, and 2 *b*.

Between extreme point of anterior articular surfaces, 8·6 in. Height, 8·7 in. Length of inferior arch (inferiorly), 2·7 in. Height of orifice, 4·3 in. Breadth of spinal canal, 3·2 in. Narrowest part, 2·1 in. Breadth of fossa for odontoid process, 2·5 in.

Figs. 3, 3 *a*, and 3 *b*.

Between extreme points of anterior articular surfaces, 9·0 in. Height, 8·1 in. Height of orifice, 3·8 in. Breadth of odontoid fossa, 2·5 in. Breadth of spinal canal, 3·8 in.

Figs. 4, 4 *a*, and 4 *b*.

Between extreme points of transverse processes, 14·8 in. Between extreme points of anterior articular surfaces, 7·5 in. Height, 7·7 in. Length of inferior arch (below) antero-posterior, 2·5 in. Great diameter of vertebral foramen, 1·2 in. Length of superior arch (antero-posterior), 3·2 in.

Fig. 5.

Height, 7·7 in.

Fig. 6.

Between extreme points of anterior articular surfaces, 7·8 in. Height, 6·6 in.

Figs. 7, 7 *a*, and 7 *b*.

Between extreme points of transverse processes, 14·7 in. Between extreme points of anterior articular surfaces, 8·7 in. Height, 7·6 in. Antero-posterior of lower arch (inferiorly), 2·6 in.

Fig. 8.

Between extreme points of transverse processes, 17·4 in. Height, 8·6 in.

Comparison between *Mukna* and *Dauntela*—*continued*.

	Mukna (big head). Inches	Dauntela. Inches
Length of anterior tooth, lower jaw	9·	dropped out
Width ditto ditto	3·37	
Length of lower jaw from tip to posterior edge at middle of height	22·5	25·
Height of jaw to alveolus	6·5	6·5
Thickness of jaw (diam.)	6·37	6·
Height of condyles	20·	18·
Height to coronoids	15·5	12·5
Antero-posterior diameter leaf	13·5	10·25
Interval between condyles, inside	14·	14·
Ditto ditto outside		21·5

The plates of teeth in the *Mukna* variety slope greatly backwards and are excessively and finely crimped; those of *Dauntela* are much less crimped.

[1] The specimens figured in Plates xlvi. to lvi. inclusive, are mostly in the British Museum, except where the contrary is stated. Except in a few instances, no attempt was made by Dr. F. to determine the species of Proboscidean to which the bone belonged.

Fig. 9.

Between extreme points of anterior articular surfaces, 7·8 in. Height, 7·7 in.

Fig. 10.

Between extreme points of anterior articular surfaces, 10·4 in. Height, 10· in. Length antero-posterior of superior arch, 3·6 in. Length antero-posterior of inferior arch, 3·1 in.

Fig. 11.

Between extreme points of anterior articular surfaces, 9·2 in. Height, 6·9 in. Antero-posterior of superior arch, 2·8 in. Antero-posterior of inferior arch, 2·1 in.

Fig. 12.—Basilar process of occipital bone with condyles and foramen magnum of a Proboscidean.

Between extreme points of occipital condyles, 10·0 in. Vertical diameter of condyle, 4·5 in. Transverse diameter of foramen magnum, 3·5 in. Vertical diameter of foramen magnum, 3·1 in.

PLATE XLVII.

Axes and other vertebræ of Proboscidea.

Figs. 1 and 1 *a*.—Axis.

Length of body inferiorly, including the odontoid, 6·0 in. Breadth of body posteriorly, 6·5 in. Height of the posterior surface of body, 5·1 in. Height of spinal canal, 2·6 in. Breadth of spinal canal, 2·2 in. Height of upper surface of spine from inferior surface of the body, posteriorly, 10·6 in. Antero-posterior diameter of spinal platform, 4·5 in.

Figs. 2 and 2 *a*.—Axis.

Length of body inferiorly, including the odontoid, 7·4 in. Breadth of body posteriorly, 6·8 in. Height of posterior surface of body, 6·3 in. Height of spinal canal, 2·8 in. Breadth of spinal canal, 2·8 in. Height of upper surface of spine from inferior surface of the body posteriorly, 13·5 in. Antero-posterior diameter of spinal platform, 5·3 in. Between extreme points of transverse processes, 12· in.

Figs. 3 and 3 *a*.—Axis.

Length of body, 4·6 in. Breadth of body posteriorly, 4·5 in. Height of body, 4·5 in.

Figs. 4 and 4 *a*.—Axis.

Length of body, 6·8 in. Breadth of body posteriorly, 6·3 in. Height of body, 5·7 in.

Figs. 5 and 5 *a*.—Axis.

Length of body, 6·4 in. Breadth of body posteriorly, 5·5 in. Height of body, 5·3 in.

Figs. 6 and 6 *a*.—Axis.

Length of body, 4·0 in. Breadth of body posteriorly, 4·4 in. Height of body, 3·6 in.

Figs. 7 and 7 *a*.—Axis.

Length of body, 6·3 in. Breadth of body posteriorly, 7·0 in. Height of body, 6·0 in.

Figs. 8 and 8 *a*.—Axis.

Length of body, 5·6 in. Breadth of body posteriorly, 6·4 in. Height of body, 5·5 in.

Figs. 9 and 9 *a*.—Axis.

Length of body, 6·0 in. Breadth of body posteriorly, 6.3 in.

Fig. 10.—Eight vertebræ conjoined. They are the posterior cervical and anterior dorsal.

Fig. 11.—Fragment of dorsal vertebra.

Height of posterior surface of body, 5·6 in. Breadth of posterior surface at inferior angles of costal pits, 5·6 in. Length of body inferiorly, 2·7 in.

Fig. 12.—Dorsal vertebra.

Between extreme points of transverse processes, 12·7 in. Height of body posteriorly, 5·5 in. Breadth of body posteriorly, 6·7 in. Length of body inferiorly, 2·8 in.

Fig. 13.—Dorsal vertebra.

Between extreme points of transverse processes, 13·2 in. Height of body posteriorly, 5·6 in. Breadth of body posteriorly, 6·2 in. Length of body inferiorly, 3·1 in.

Fig. 13 *a*.—Dorsal vertebra.

Between extreme points of transverse processes, 14· in. Height of body posteriorly, 6·7 in. Length of body inferiorly, 3·7 in.

Fig. 14.—Lumbar vertebra.

Height of body posteriorly, 5· in. Breadth of body posteriorly, 5·5 in. Length of body inferiorly, 3· in. Between extreme points of transverse processes, 8·5 in.

Fig. 15.—Lumbar vertebra.

Height of body posteriorly, 3·7 in. Breadth of body posteriorly, 4·2 in. Length of body inferiorly, 3·2 in. Between extreme points of transverse processes, 6·5 in.

Fig. 16.—Portion of sacrum, comprising three upper sacral vertebra and portion of a fourth.

Length of fragment, 13·3 in. Length of three upper sacral vertebræ, 10·2 in. Between extreme points of transverse processes, 10·4 in. Height of body (upper, right), 3·5 in. Transverse of body (upper), 6·1 in.

Plate XLVIII.

Bones of anterior extremity of Proboscidea.

Figs. 1, 1 *a*, and 1 *b*.—*Elephas Namadicus*, from the Nerbudda. Upper end of shaft, and articulating extremity of left humerus.

Length of fragment, 29·6 in. Transverse diameter of upper extremity, 14·4 in. Antero-posterior diameter of great tuberosity, 12·2 in. Antero-posterior diameter of head (articular surface), 11·8 in. Transverse diameter, 8· in. Smallest transverse diameter of shaft in centre, 10·3 in. Smallest antero-posterior diameter of shaft, in centre, 3·7 in.

Figs. 2, 2 *a*, and 2 *b*.—*E. Namadicus*. Fragment of shaft and upper articulating extremity of united radius and ulna, left side. Specimen formerly in United Service Museum.

Extreme length, 40· in. Extreme width below sigmoid cavity in fig. 2 *a*, 10· in. Depth from upper and back part of olecranon to anterior angle of sigmoid cavity, fig. 2 *b*, 14·5 in.

Figs. 3, 3 *a*, and 3 *b*.—Fragment of shaft and upper end of left humerus of a Proboscidean.

Length of fragment, 18·8 in. Transverse diameter of upper extremity, 12·2 in. Antero-posterior diameter of great tuberosity, 11· in.

Fig. 4.—Upper articulating end of left humerus.

Length, 13·5 in. Transverse diameter, 10·5 in. Antero-posterior diameter of great tuberosity, 11· in.

Fig. 5.—Upper articulating end of left humerus.

Length of fragment, 18·2 in. Transverse diameter of upper end, 13· in. Antero-posterior diameter of great tuberosity, 10·5 in. Antero-posterior diameter of articular surface of head, 9·8 in. Transverse diameter of articular surface of head, 6·4 in.

Fig. 6.—Upper articulating end of left humerus.

Length, 13· in. Transverse diameter of upper end, 12· in. Antero-posterior diameter of great tuberosity, 10·5 in.

Fig. 7.—Upper articulating end of right humerus.

Length, 15· in. Transverse diameter of upper end, 12·7 in. Antero-posterior diameter of articular surface, 9·2 in. Transverse diameter of articular surface, 7·5 in.

Fig. 8.—Upper articulating end of left humerus.

Length, 11·6 in. Transverse diameter of upper end, 9· in. Antero-posterior diameter of great tuberosity, 8·5 in.

Fig. 9.—Upper articulating end of right humerus.

Length, 9·5 in. Transverse diameter of upper end, 9·5 in. Antero-posterior diameter of great tuberosity, 9·5 in. Antero-posterior diameter of articular surface, 7·9 in. Transverse diameter of articular surface, 6·2 in.

Fig. 10.—Upper articulating end of left humerus.

Length, 11·4 in. Transverse diameter of upper end, 9·4 in. Antero-posterior diameter of great tuberosity, 7·7 in. Antero-posterior diameter of articular surface, 6·8 in. Transverse diameter of articular surface, 5·5 in.

Figs. 11, 11 *a*, and 11 *b*.—Lower end of shaft and articular surface of left humerus.

Length of fragment, 21·5 in. Breadth of inferior extremity, including external condyloid ridge, 11· in. Breadth of trochlear surface, 9·5 in. Smallest antero-posterior diameter of trochlear surface, 4·4 in. Circumference at broken extremity, 18·7 in.

Figs. 12, 12 *a*, and 12 *b*.—Lower end of shaft and articular surface of left humerus.

Length, 14·3 in. Breadth of inferior extremity, including external condyloid ridge, 10·2 in. Breadth of trochlear surface, 8·6 in. Smallest antero-posterior diameter of trochlear surface, 4·1 in.

Figs. 13, 13 *a*, and 13 *b*.—Lower end of shaft and articular surface of right humerus.

Length, 17·3 in. Breadth of inferior extremity, including external condyloid ridge, 12· in. Breadth of trochlear surface, 9·3 in. Smallest antero-posterior diameter of trochlear surface, 4·7 in.

Figs. 14, 14 *a*, and 14 *b*.—Lower end of shaft and articular surface of left humerus.

Length, 14· in. Breadth of inferior extremity, including external condyloid ridge, 14·7 in. Breadth of trochlear surface, 11·9 in. Smallest antero-posterior diameter of trochlear surface, 4·4 in.

Fig. 15.—Lower articulating end of left humerus.

Breadth of inferior extremity, including external condyloid ridge, 13· in. Breadth of trochlear surface, 10· in. Smallest antero-posterior diameter of trochlear surface, 4·5 in.

Fig. 16.—Lower articulating end of left humerus.

Breadth of inferior extremity, including external condyloid ridge, 9· in. Breadth of trochlear surface, 7·3 in. Smallest antero-posterior diameter of trochlear surface, 3·3 in.

Fig. 17.—Lower articulating end of right humerus.

Length, 13·5 in. Breadth of inferior extremity, including external condyloid ridge, 11· in. Breadth of trochlear surface, 9·8 in. Smallest antero-posterior diameter of trochlear surface, 5· in.

Fig. 18.—Lower articulating end of left humerus.

Breadth of inferior extremity, including external condyloid ridge, 9·7 in.

Breadth of trochlear surface, 8·5 in. Smallest antero-posterior diameter of trochlear surface, 3·5 in.

Fig. 19.—Lower articulating end of right humerus.

Length, 15· in. Breadth of inferior extremity, including external condyloid ridge, 12·4 in. Breadth of trochlear surface, 9·7 in. Smallest antero-posterior diameter of trochlear surface, 4· in.

Fig. 20.—Lower articulating end of right humerus.

Breadth of inferior extremity, including external condyloid ridge, 12· in. Breadth of trochlear surface, 9·6 in. Smallest antero-posterior diameter of trochlear surface, 4·7 in.

Fig. 21.—Lower articulating end of right humerus.

Length, 15·7 in. Breadth of inferior extremity, including external condyloid ridge, 12·4 in. Breadth of trochlear surface, 10·1 in. Smallest antero-posterior diameter of trochlear surface, 4·3 in.

Figs. 22, 22 *a*, and 22 *b*.—Upper end of shaft and articular surface of united radius and ulna, left side.

Length, 22·4 in. Width of upper end or head (fig. 22 *a*), 7·4 in. Depth (fig. 22 *b*), 10·5 in.

Figs. 23 and 23 *b*.—Upper end of shaft and articular surface of united radius and ulna, right side.

Length, 17· in. Width of upper end or head, 7·5 in. Depth (*b*), 12·2 in.

Fig. 24.—Upper articular surface of radius and ulna, right side.

Width of upper end or head, 9·6 in. Depth, 12·7 in.

Fig. 25.—Upper articular surface of radius and ulna, left side.

Width of upper end or head, 7· in. Depth, 10·8 in.

Fig. 26.—Upper articular surface of radius and ulna, left side.

Width, 7·8 in. Depth, 10·2 in.

Fig. 27.—Upper articular surface of radius and ulna, left side.

Width, 6·8 in. Depth, 10· in.

Fig. 28.—Upper articular surface of radius and ulna, left side.

Depth to internal angle of ulna, 10·7 in.

Figs. 29 and 29 *a*.—Upper articular surface of radius and ulna, right side.

Length, 12·5 in. Depth to internal angle of ulna, 11·3 in.

PLATE XLIX.

Bones of anterior extremity of Proboscidea.

Fig. 1.—Fragment of right scapula, showing spine, glenoid cavity, &c.

Length of fragment, 22·7 in. Breadth of fragment (greatest), 13· in. Greatest height of spine above infra-spinous fossa, 7·2 in. Greatest diameter of glenoid cavity, 7·5 in. Lesser diameter of glenoid cavity, 5· in.

Figs. 2 and 2 *a*.—Fragment of right scapula, showing spine and glenoid cavity.

Length of scapula, 31· in. Breadth of fragment, 11·2 in. Height of spine, 7·5 in.

Fig. 3.—Fragment of right scapula, including glenoid cavity.

Length of fragment, 14· in. Greatest diameter of glenoid cavity, 6·6 in. Lesser diameter of glenoid cavity, 3·6 in

Figs. 4 and 4 *b*.—Fragment of right scapula, including glenoid cavity.

Length of fragment, 14·8 in. Greatest diameter of glenoid cavity, 9·4 in. Lesser diameter of glenoid cavity, 5·5 in.

Figs. 5, 5 *a*, and 5 *b*.—Upper end of shaft and articular head of right humerus.

Extreme length, 22· in. Transverse diameter of upper extremity, 9·7 in. Antero-posterior of great tuberosity, 8·5 in. Antero-posterior of articular surface of head, 7·3 in. Transverse surface of head, 4·2 in. Smallest transverse diameter of shaft, 4·7 in. Smallest antero-posterior diameter of shaft, 3·2 in.

Figs. 6, 6 *a*, and 6 *b*.—Lower end of shaft and articular surface of left humerus.

Length, 17·6 in. Breadth of inferior extremity, including condyloid ridge, 12· in. Transverse diameter of trochlea, 9·3 in. Smallest antero-posterior diam. of trochlea, 4·2 in.

Figs. 7, 7 *a*, and 7 *b*.—Lower end of shaft and articular surface of left humerus.

Length, 14· in. Breadth of inferior extremity, including condyloid ridge, 10· in. Transverse diameter of trochlea, 8·6 in. Smallest antero-posterior diameter of trochlea, 4·3 in.

Figs. 8, 8 *a*, and 8 *b*.—Upper articulating extremity of left radius and ulna.

Length, 19·2 in. Breadth of sigmoid cavity, 9·7 in. Depth or greatest oblique diameter from before backwards (*a*), 12·9 in.

Fig. 9.—Lower end of right radius and ulna.

Length, 14· in. Width of united extremities, 11· in. Width of ulna, 7·3 in.

Figs. 10 and 10 *a*.—Lower end of left radius and ulna.

Length, 12·5 in. Width of united extremities, 11·4 in. Width of ulna, 6·2 in. Width of radius, 4·6 in.

Figs. 11 and 11 *a*.—Lower end of right radius and ulna. This specimen is from Perim Island.

Extreme length, 14·2 in. Width of conjoined ends, 10· in. Width of ulna, 4·5 in. Width of radius, 6· in.

Figs. 12 and 12 *a*.—Lower end of right radius and ulna.

Length, 10·4 in. Breadth of inferior extremity, 6·3 in.

Figs. 13 and 13 *a*.—Lower end of left ulna.

Length, 13·5 in. Breadth of inferior extremity, 5·9 in. Antero-posterior diameter of inferior extremity, 5·3 in.

Figs. 14 and 14 *a*.—Lower end of right ulna.

Length, 8·5 in. Breadth of inferior end, 6·4 in. Antero-posterior diameter of inferior end, 5·6 in.

Fig. 15.—Lower end of right radius and ulna. The radius is to right of figure.

Length, 12·2 in. Breadth of conjoined extremities, 10·5 in.

Fig. 16.—Lower end of right radius and ulna.

Breadth of conjoined extremities, 9·4 in. Breadth of ulna, 5·5 in. Breadth of radius, 4·3 in.

Fig. 17.—Lower end of right ulna.

Breadth, 5·3 in.

Fig. 18.—Lower end of right ulna.

Breadth, 6·2 in.

Fig. 19.—Lower end of right radius.
Length, 11·8 in. Breadth of inferior extremity, 6·4 in.

Fig. 20.—Lower end of left radius.
Breadth, 4·2 in. Antero-posterior diameter, 5·8 in.

Fig. 21.—Lower end of right radius.
Breadth, 5·5 in.

Fig. 22.—Lower end of left ulna.
Breadth, 5·6 in.

Fig. 23.—Lower end of right radius.
Breadth, 3·9 in.

Fig. 24.—Lower end of right radius.
Breadth of inferior extremity, 4·3 in. Extreme length, 8·8 in. Antero-posterior diameter of inferior extremity, 5·2 in.

Fig. 25.—Lower end of left ulna.
Length, 10·5 in. Breadth of inferior extremity, 5·8 in. Antero-posterior diam. of inferior extremity, 5·4 in.

Fig. 26.—Lower end of left radius.
Breadth, 3·4 in.

Fig. 27.—Lower end of left radius.
Length, 17·7 in. Breadth of inferior extremity, 4· in.

Fig. 28.—Lower end of left radius.
Breadth, 4·8 in.

Fig. 29.—Lower end of left ulna.
Breadth of inferior extremity, 5·3 in. Antero-posterior of inferior extremity, 4·3 in.

Fig. 30.—Lower end of left ulna.
Breadth, 4·8 in.

Fig. 31.—Lower end of left ulna.
Breadth, 5·5 in. Antero-posterior diameter, 5·5 in.

Fig. 32.—Lower end of right ulna.
Breadth, 4· in.

Fig. 33.—Lower end of left ulna.
Breadth, 7·1 in. Antero-posterior diameter, 4·4 in.

Fig. 34.—Lower end of right ulna.
Breadth, 7· in. Antero-posterior diameter, 6· in.

Fig. 35.—Lower end of left ulna.
Breadth, 7·1 in. Antero-posterior diameter, 6·4 in.

Fig. 36.—Lower end of right ulna.
Breadth, 7·4 in. Antero-posterior diameter, 6·8 in.

Plate L.

Bones of anterior extremity of Proboscidea.

Fig. 1.—Lower end of right radius and ulna, with bones of carpus (semilunar, trapezoid, os magnum and unciform) and metacarpus (second, third, and fourth).
Length of fragment of ulna, 10·9 in. Length of fragment of radius, 9·2 in. Breadth of semilunar, 4·7 in. Vertical diameter of semilunar in centre, 2·5 in. Vertical diameter of trapezoid, 2·6 in. Transverse diameter of trapezoid, 3·2 in. Transverse diameter of os magnum, 3· in. Vertical diameter of os magnum, 2·9 in.

Transverse diameter of unciform, 4· in. Vertical diameter of unciform, 3· in. Length of second metacarpal, 4·5 in. Breadth of second metacarpal, 2·5 in. Length of third metacarpal, 4·2 in. Breadth of third metacarpal, 3·3 in. Length of fourth metacarpal, 2·5 in. Breadth of fourth metacarpal, 2·5 in. Breadth of inferior extremity of radius, 4·8 in. Breadth of inferior extremity of ulna, 7· in.

Figs. 2, 2 *a*, and 2 *b*.—Lower end of left ulna (*a*), with bones of carpus (scaphoid (1), semilunar (2), cuneiform (3), pisiform (4), trapezium (5), trapezoid (6), os magnum (7), and unciform (8)), and middle metacarpal (9).

Breadth of lower extremity of ulna, 5·5 in. Vertical diameter of scaphoid, 5·1 in. Antero-posterior diameter of scaphoid, 3·9 in. Transverse diameter of scaphoid, 2·1 in. Vertical diameter of semilunar, 2·9 in. Antero-posterior diameter of semilunar, 5·2 in. Transverse diameter of semilunar, 5·6 in. Vertical diameter of cuneiform, 2·8 in. Antero-posterior diameter of cuneiform, 4·7 in. Transverse diameter of cuneiform, 7· in. Vertical diameter of pisiform, 5·3 in. Transverse diameter of pisiform, 3·4 in. Antero-posterior diameter of pisiform, 2·1 in. Vertical diameter of trapezium, 3·7 in. Transverse diameter of trapezium, 4·6 in. Antero-posterior diameter of trapezium, 3·3 in. Vertical diameter of trapezoid, 2·3 in. Transverse diameter of trapezoid, 3·3 in. Antero-posterior diameter of trapezoid, 3·5 in. Vertical diameter of os magnum, 3·1 in. Transverse diameter of os magnum, 3·2 in. Antero-posterior diameter of os magnum, 4·8 in. Vertical diameter of unciform, 3·3 in. Transverse diameter of unciform, 5· in. Antero-posterior diameter of unciform, 4·3 in. Transverse diameter of medius metacarpal, 2·7 in. Antero-posterior diameter of medius metacarpal, 4· in.

Figs. 3 and 3 *a*.—Right scaphoid.

Figs. 4 and 4 *a*.—Left scaphoid.

Length, 5·6 in. Breadth, 3·8 in. Thickness, 2·6 in.

Figs. 5 and 5 *a*.—Left scaphoid.

Length, 4·9 in. Breadth, 4·1 in. Thickness, 2·3 in.

Figs. 6, 6 *a*, and 6 *b*.—Right semilunar.

Height, 2·8 in. Breadth, 5·3 in. Antero-posterior diameter, 5· in.

Figs. 7, 7 *a*, and 7 *b*.—Left semilunar.

Height, 2·8 in. Breadth, 4·2 in. Antero-posterior diameter, 4·6 in.

Figs. 8, 8 *a*, and 8 *b*.—Right semilunar.

Height, 2·5 in. Breadth, 4·4 in. Antero-posterior diameter, 4·5 in.

Figs. 9, 9 *a*, and 9 *b*.—Right semilunar.

Height, 2·7 in. Breadth, 4·4 in. Antero-posterior diameter, 4·5 in.

Figs. 10, 10 *a*, and 10 *b*.—Right semilunar.

Height, 3· in. Breadth, 5·4 in. Antero-posterior diameter, 5·8 in.

Figs. 11, 11 *a*, and 11 *b*.—Right semilunar.

Height, 2·7 in. Breadth, 4·4 in. Antero-posterior diameter, 4·8 in.

Figs. 12, 12 *a*, and 12 *b*.—Left semilunar.

Height, 2·7 in. Breadth, 4·6 in. Antero-posterior diameter, 4·2 in.

Figs. 13, 13 *a*, and 13 *b*.—Right semilunar.

Height, 3· in. Breadth, 5·5 in. Antero-posterior diameter, 5· in.

Figs. 14, 14 *a*, and 14 *b*.—Left semilunar.

Height, 2·2 in. Breadth, 4·3 in. Antero-posterior diameter, 4·2 in.

Figs. 15, 15 *a*, and 15 *b*.—Right semilunar.

Height, 2·6 in. Breadth, 4·8 in. Antero-posterior diameter, 5·1 in.

Figs. 16, 16 *a*, and 16 *b*.—Right cuneiform.

Height, 2·1 in. Transverse diameter, 5·3 in. Antero-posterior diameter, 4·3 in.

Figs. 17, 17 *a*, and 17 *b*.—Right cuneiform.
Height, 1·7 in. Transverse diameter, 4·8 in. Antero-posterior diameter, 3·3 in.

Figs. 18, 18 *a*, and 18 *b*.—Right cuneiform.
Height, 2·6 in. Transverse diameter, 5·8 in. Antero-posterior diameter, 4·4 in.

Figs. 19, 19 *a*, and 19 *b*.—Right cuneiform.
Height, 2·8 in. Transverse diameter, 6·4 in. Antero-posterior diameter, 4·4 in.

Figs. 20, 20 *a*, and 20 *b*.—Right cuneiform.

Figs. 21, 21 *a*, and 21 *b*.—Left cuneiform.
Height, 2·5 in. Transverse diameter, 5·2 in. Antero-posterior diameter, 4·3 in.

Figs. 22 and 22 *a*.—Left pisiform.
Height, 5·3 in. Breadth, 3·5 in. Thickness, 2·3 in.

Figs. 23 and 23 *a*.—Left pisiform.
Height, 5·1 in. Breadth, 2·8 in. Thickness, 2· in.

Figs. 24 and 24 *a*.—Left pisiform.
Height, 4·6 in. Breadth, 3· in. Thickness, 2· in.

Figs. 25 and 25 *a*.—'Figured by mistake. Ought to have been erased.'—[H.F.]

Figs. 26, 26 *a*, 26 *b*, and 26 *c*.—Left trapezoid.
Height, 2·5 in. Breadth, 3· in. Antero-posterior diameter, 4·1 in.

Figs. 27, 27 *a*, 27 *b*, and 27 *c*.—Right trapezoid.
Height, 2·5 in. Breadth, 3·2 in. Antero-posterior diameter, 4·3 in.

PLATE LI.

Bones of anterior extremity of Proboscidea.

Figs. 1, 1 *a*, 1 *b*, 1 *c*, and 1 *d*.—Left os magnum.

Figs. 2, 2 *a*, 2 *b*, 2 *c*, and 2 *d*.—Left os magnum.
Antero-posterior diameter, 5·3 in. Transverse, 3·6 in. Vertical, 4·4 in.

Figs. 3, 3 *a*, 3 *b*, 3 *c*, and 3 *d*.—Left os magnum.
Antero-posterior diameter, 5·1 in. Transverse, 3·8 in. Vertical, 4·4 in.

Figs. 4, 4 *a*, 4 *b*, 4 *c*, and 4 *d*.—Left os magnum.
Antero-posterior diameter, 5·2 in. Transverse, 3·3 in. Vertical, 4·4 in.

Figs. 5, 5 *a*, 5 *b*, 5 *c*, and 5 *d*.—Right os magnum.
Antero-posterior diameter, 5·6 in. Transverse, 4·3 in.

Figs. 6, 6 *a*, 6 *b*, 6 *c*, and 6 *d*.—Left os magnum.
Antero-posterior diameter, 6·4 in. Transverse, 5·8 in. Vertical, 5·7 in.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Right unciform.
Antero-posterior diameter, 4·7 in. Transverse, 4·4 in. Vertical, 4·7 in.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—Left unciform.
Antero-posterior diameter, 5·6 in. Transverse, 5· in. Vertical, 5·1 in.

Figs. 9, 9 *a*, 9 *b*, and 9 *c*.—Left unciform.
Antero-posterior diameter, 5· in. Transverse, 4·6 in. Vertical, 3·8. in.

Figs. 10, 10 *a*, 10 *b*, and 10 *c*.—Right unciform.
Antero-posterior diameter, 5·2 in. Transverse, 5· in. Vertical, 4·7 in.

Figs. 11, 11 *a*, 11 *b*, and 11 *c*.—Left unciform.
Antero-posterior diameter, 4·7 in. Transverse, 4·5 in. Vertical, 4·2 in.

Figs. 12, 12 *a*, 12 *b*, and 12 *c*.—Left unciform.
Antero-posterior diameter, 4· in. Transverse, 3·6 in. Vertical, 3·5 in.

Figs. 13, 13 *a*, and 13 *b*.—Left pollex metacarpal.
Length, 5·2 in. Height of posterior surface, 3·8 in. Breadth ditto, 2·3 in.

Figs. 14, 14 *a*, and 14 *b*.—Right index metacarpal.
Length, 8·3 in. Breadth of posterior surface, 2·9 in.

Figs. 15, 15 *a*, and 15 *b*.—Left index metacarpal.
Length, 6·8 in. Height of posterior surface, 3·3 in. Breadth ditto, 2·5 in.

Figs. 16, 16 *a*, and 16 *b*.—Left index metacarpal.
Length, 6·9 in. Height of posterior surface, 4·3 in. Breadth ditto, 2·6 in.

Figs. 17, 17 *a*, and 17 *b*.—Right medius metacarpal.
Length, 7·8 in. Height of posterior surface, 4· in. Breadth ditto, 2·8 in.

Figs. 18, 18 *a*, and 18 *b*.—Right medius metacarpal.
Length, 8·5 in. Height of posterior surface, 4·9 in. Breadth of ditto, 3·8 in.

Figs. 19, 19 *a*, and 19 *b*.—Right medius metacarpal.
Length, 8·6 in. Height of posterior surface, 4·8 in. Breadth of ditto, 3·4 in.

Figs. 20, 20 *a*, and 20 *b*.—Right medius metacarpal.
Length, 10· in. Height of posterior surface, 5· in. Breadth of ditto, 4·5 in.

Figs. 21, 21 *a*, and 21 *b*.—Left annular metacarpal.
Length, 7·1 in. Height of posterior surface, 3·9 in. Breadth of ditto, 3·4 in.

Figs. 22, 22 *a*, and 22 *b*.—Left annular metacarpal.
Length, 8· in. Height of posterior surface, 3·8 in. Breadth of ditto, 3·5 in.

Figs. 23, 23 *a*, and 23 *b*.—Left annular metacarpal.
Length, 7·3 in. Height of posterior surface, 3·6 in. Breadth of ditto, 3· in.

Figs. 24, 24 *a*, and 24 *b*.—Right minimus metacarpal.
Length, 6· in. Height of posterior surface, 2·9 in. Breadth of ditto, 2·6 in.

Figs. 25, 25 *a*, and 25 *b*.—Right minimus metacarpal.
Length, 7·4 in. Height of posterior surface, 4·1 in. Breadth of ditto, 4·4 in.

Figs. 26, 26 *a*, and 26 *b*.—Left minimus metacarpal.
Length, 7·3 in. Height of posterior surface, 3·6 in. Breadth of ditto, 3·7 in.

Figs. 27, 27 *a*, and 27 *b*.—Right medius first phalanx.
Length, 4·3 in. Height of posterior surface, 2·6 in. Breadth of ditto, 3·9 in.

Figs. 28, 28 *a*, and 28 *b*.—Left annular first phalanx.
Length, 4· in. Height of posterior surface, 2·6 in. Breadth of ditto, 3·6 in.

Figs. 29, 29 *a*, and 29 *b*.—Right medius metacarpal.
Length, 3·7 in. Height of posterior surface, 2·3 in. Breadth of ditto, 3·3 in.

Figs. 30, 30 *a*, and 30 *b*.—Left medius metacarpal.
Length, 2·7 in. Height of posterior surface, 1·8 in. Breadth of ditto, 2·6 in.

Plate LII.

Bones of posterior extremity of Proboscidea.

Fig. 1.—Head, neck, and great trochanter of left femur.
Length of fragment, 20· in. Breadth of upper extremity, including great trochanter, 15·7 in. Antero-posterior diameter of head, 7·5 in. Transverse diameter of broken extremity, 7·5 in. Antero-posterior diameter of broken extremity, 3·6 in.

Fig. 2.—Head, neck, and great trochanter of right femur.

Length, 17·5 in. Breadth of upper end, 15· in. Antero-posterior diameter of head, 7· in.

Fig. 3.—Head, neck, and upper part of shaft of right femur.

Length, 17· in. Breadth of upper end, 12· in. Antero-posterior diameter of head, 6· in.

Fig. 4.—Head, neck, and upper part of shaft of right femur.

Length, 18·3 in. Breadth of upper end, 13· in. Antero-posterior diameter of head, 6·6 in.

Fig. 5.—Head, neck, and upper part of shaft of left femur.

Length, 15· in. Breadth of upper end, 11·3 in. Antero-posterior diameter of head (imperfect), 6· in.

Fig. 6.—Head, neck, and upper part of shaft of right femur.

Length, 14·3 in. Breadth of upper end, 14·7 in. Antero-posterior diameter of head, 6·4 in.

Fig. 7.—Head, neck, and upper part of shaft of right femur.

Length, 18· in. Breadth of upper end, 12· in. Antero-posterior diameter of head, 6·4 in.

Fig. 8.—Head, neck, and great trochanter of left femur.

Length, 13· in. Breadth of upper end, 15· in. Antero-posterior diameter of head, 7·2 in.

Figs. 9, 9 *a*, 9 *b*, and 9 *c*.—Lower end of right femur with articulating surface.

Length, 17·6 in. Transverse diameter of lower end, 9· in. Antero-posterior diameter internally, 8·5 in. Ditto, externally, 8·5 in.

Figs. 10, 10 *a*, 10 *b*, and 10 *c*.—Lower end of right femur with articulating surface.

Length, 21·4 in. Transverse diameter of lower end, 8·3 in. Antero-posterior diameter internally, 8·6 in. Circumference at fractured end, 13·7 in.

Figs. 11, 11 *a*, 11 *b*, and 11 *c*.—Lower end of right femur with articulating surface.

Length, 13· in. Transverse diameter of lower end, 9·4 in.

Figs. 12, 12 *a*, 12 *b*, and 12 *c*.—Lower end of left femur with articulating surface.

Length, 13·7 in. Transverse diameter of lower end, 9·2 in. Antero-posterior diameter internally, 9·6 in. Ditto, externally, 8·5 in. Transverse diameter of rotular surface, 4·2 in. Height in centre of ditto, 4·1 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Lower end of right femur with articulating surface.

Length, 11·5 in. Transverse diameter of lower end, 7·9 in. Antero-posterior diameter externally, 7·1 in. Transverse diameter of rotular surface, 3·7 in. Height in centre of rotular surface, 3·6 in.

Figs. 14, 14 *a*, and 14 *b*.—Lower end of left femur, with articulating surface.

Length, 14· in. Transverse diameter of lower end, 7·7 in.

Fig. 15.—Lower end of right femur with articulating surface.

Length, 17· in. Transverse diameter of lower end, 9·6 in. Antero-posterior diameter internally, 10·4 in.

Fig. 16.—Lower end of left femur with articulating surface.

Length, 8·6 in. Transverse diameter of lower end, 8·3 in. Antero-posterior diameter internally, 7·8 in. Ditto, externally, 7·1 in. Transverse diameter of rotular surface, 3·8 in. Height in centre of rotular surface, 3·8 in.

Fig. 17.—Lower epiphysis of left femur.

Transverse diameter, 8· in. Transverse diameter of rotular surface, 3·7 in. Vertical diameter of rotular surface in centre, 3·8 in.

Fig. 18.—Lower articulating surface of right femur.

Length, 9·3 in. Transverse diameter, 8·2 in. Antero-posterior diameter internally, 9·8 in. Antero-posterior diameter externally, 8·4 in. Transverse diameter of rotular surface, 3·8 in. Vertical diameter of rotular surface in centre, 4·1 in.

Fig. 19.—Lower articulating surface of right femur.

Length, 13· in. Transverse diameter of lower end, 9· in. Antero-posterior diameter, externally, 8· in.

Fig. 20.—Lower end of left femur.

Length, 11· in. Transverse diameter of lower end, 7· in. Antero-posterior diameter internally, 7·1 in. Antero-posterior diameter externally, 6·4 in. Transverse diameter of rotular surface, 3·1 in. Vertical diameter of rotular surface in centre, 3·8 in.

Fig. 21.—Lower end of left femur.

Transverse diameter, 8·7 in. Antero-posterior diameter internally, 8·7 in. Antero-posterior diameter externally, 7·9 in. Transverse diameter of rotular surface, 4·1 in. Vertical diameter of rotular surface in centre, 4·1 in.

Fig. 22.—Lower end of right femur.

Length, 15·4 in. Transverse diameter of lower end, 10·3 in.

Fig. 23.—Lower end of right femur.

Length, 11·5 in. Transverse diameter of lower end, 9·2 in Antero-posterior diameter internally, 9·4 in. Antero-posterior diameter externally, 8·3 in. Transverse diameter of rotular surface, 4· in. Vertical diameter of rotular surface, 4·6 in.

Fig. 24.—Lower end of right femur.

Length, 10·8 in. Transverse diameter of lower end, 8·1 in. Antero-posterior diameter internally, 8·3 in. Antero-posterior diameter externally, 7·5 in. Transverse diameter of rotular surface, 4·2 in. Vertical diameter of rotular surface, 4·1 in.

Fig 25.—Lower end of right femur.

Length, 11· in. Transverse diameter of lower end, 8· in. Antero-posterior diameter internally, 8·3 in. Antero-posterior diameter externally, 7·6 in. Height of rotular surface, 3·7 in.

Fig. 26.—Lower end of right femur.

Transverse diameter of lower end, 9·5 in. Antero-posterior diameter internally, 9·8 in. Ditto, externally, 8·7 in.

Fig. 27.—Lower end of left femur.

Length, 11·2 in. Transverse diameter of lower end, 10· in. Antero-posterior diameter internally, 10·1 in. Ditto externally, 9· in. Transverse diameter of rotular surface, 5·1 in. Vertical diameter of rotular surface, 5· in.

Fig. 28.—Lower end of right femur.

Length, 13·5 in. Transverse diameter of lower end, 9·4 in. Antero-posterior diameter internally, 10·6 in. Ditto externally, 9·2 in.

Fig. 29.—Lower end of left femur.

Length, 11·4 in. Transverse diameter of lower end, 8·8 in. Antero-posterior diameter internally, 9·2 in. Ditto externally, 7·6 in. Transverse diameter of rotular surface, 3·7 in. Vertical diameter of rotular surface in centre, 4· in.

Fig. 30.—Lower end of left femur.

Length, 15· in. Transverse diameter of lower end, 7·5 in.

PLATE LIII.

Bones of trunk and posterior extremity of Proboscidea.

Fig. 1.—Fragment of pelvis, right side, showing acetabulum.

Length of fragment, 19· in. Great diameter of acetabulum 7· in. Lesser ditto, 6·5 in.

Figs. 2 and 2 *a*.—Fragment of pelvis showing acetabulum.

Length of fragment, 17· in. Great diameter of acetabulum, 6· in..

Fig. 3.—Fragment of pelvis, showing acetabulum.

Length of fragment, 15· in. Great diameter of acetabulum, 7·6 in. Lesser ditto, 7·4 in.

Fig. 4.—Fragment of pelvis, showing acetabulum.

Length of fragment, 17· in. Great diameter of acetabulum, 8·2 in. Lesser ditto, 7·6 in.

Fig. 5.—Fragment of pelvis, showing acetabulum.

Length of fragment, 13·7 in. Great diameter of acetabulum, 6· in. Lesser ditto, 5·4 in.

Fig. 6.—Fragment of pelvis, showing acetabulum.

Length, 14· in. Great diameter of acetabulum, 7· in. Lesser ditto, 6·8 in.

Fig. 7.—Fragment of pelvis, showing acetabulum.

Length, 16·2 in. Great diameter of acetabulum, 7·5 in. Lesser ditto, 7· in.

Fig. 8.—Fragment of pelvis, showing acetabulum.

Length, 13· in. Great diameter of acetabulum, 7·3 in. Lesser ditto, 6·9 in.

Fig. 9.—Head, neck, and upper part of shaft of right femur.

Length of fragment, 35·5 in. Breadth of upper extremity, including great trochanter, 13· in. Antero-posterior diameter of articular surface, 7·1 in. Smallest transverse diameter, 5·6 in. Antero-posterior diameter of shaft, 3·5 in.

Figs. 10 and 10 *a*.—Head of femur.

Greater diameter, 8·5 in. Lesser ditto, 7·8 in.

Figs. 11 and 11 *a*.—Lower end of right femur and articular surface of *Elephas primigenius*.

Length of fragment (longer than the figure), 34· in. Breadth of lower end, 7·2 in. Antero-posterior diameter internally, 7·9 in. Ditto externally, 6·6 in. Height of rotular surface in centre, 3·2 in. Breadth of ditto, 3·1 in.

Figs. 12 and 12 *a*.—Lower articulating end of right femur.

Breadth of lower extremity, 10·7 in.

Fig. 13.—Lower end of right femur of *Elephas antiquus*, from Walton in Essex.

Breadth, 10· in. Antero-posterior diameter internally, 9·5 in. Ditto externally, 8·8 in. Height of rotular surface in centre, 4·1 in. Breadth of ditto, 4·5 in.

Figs. 14 and 14 *a*.—Upper end of left tibia.

Length of fragment, 10·7 in. Transverse diameter of upper end, 9·5 in. Greatest antero-posterior diameter of ditto, 5·6 in.

Figs. 15 and 15 *a*.—Upper end of right tibia.

Length, 13·5 in. Transverse diameter of upper end, 9·7 in. Greatest antero-posterior diameter of ditto, 7·3 in.

Figs. 16 and 16 *a*.—Upper end of right tibia.

Length, 15 6 in. Transverse diameter of upper extremity (imperfect), 9·3 in. Greatest antero-posterior diameter of ditto, 7· in.

Figs. 17 and 17 *a*.—Upper end of right tibia.

Length, 12·7 in. Transverse diameter of upper extremity, 8·2 in.

Fig. 18.—Upper articulating surface of right tibia.

Transverse diameter, 9·7 in. Greatest antero-posterior diameter, 7·3 in.

Fig. 19.—Upper articulating surface of right tibia.

Transverse diameter, 9·6 in. Greatest antero-posterior ditto, 6·8 in.

Fig. 20.—Upper articulating surface of right tibia.

Transverse diameter, 6·8 in. Greatest antero-posterior ditto, 5· in.

Fig. 21.—Upper articulating surface of right tibia.

Transverse diameter, 7·4 in. Greatest antero-posterior ditto, 5·2 in.

Fig. 22.—Upper articulating surface of right tibia.

Transverse diameter, 7·3 in. Greatest antero-posterior ditto, 5·7 in.

Fig. 23.—Upper articulating surface of left tibia.

Transverse diameter, 8· in. Greatest antero-posterior ditto, 6·5 in.

Fig. 24.—Upper articulating surface of right tibia.

Transverse diameter, 7·8 in. Greatest antero-posterior ditto, 6· in.

Fig. 25.—Upper articulating surface of left tibia.

Transverse diameter, 8· in. Greatest antero-posterior ditto, 5·5 in.

Fig. 26.—Upper articulating surface of left tibia.

Transverse diameter, 10· in. Greatest antero-posterior ditto, 7·2 in.

Figs. 27 and 27 *a*.—Upper end of left tibia.

Length, 9·6 in. Transverse diameter of upper surface, 9·4 in. Greatest antero-posterior diameter of ditto, 7· in.

Fig. 28.—Upper articulating surface of right tibia.

Transverse diameter, 7·4 in. Greatest antero-posterior diameter, 6· in.

Fig. 29.—Upper articulating surface of left tibia.

Transverse diameter, 8·7 in. Greatest antero-posterior diameter, 5·6 in.

Fig. 30.—Upper articulating surface of left tibia.

Transverse diameter, 10· in. Greatest antero-posterior diameter, 6·5 in.

Fig. 31.—Lower articulating surface of left tibia.

Transverse diameter, 8·7 in. Greatest antero-posterior diameter, 6·7 in.

Figs. 32 and 32 *a*.—Lower end of left tibia.

Length of fragment, 9·5 in. Transverse diameter of lower end, 6·9 in. Antero-posterior diameter of ditto, 5·3 in.

Figs. 33 and 33 *a*.—Lower end of right tibia.

Length, 7·7 in. Transverse diameter of lower end, 7·7 in. Antero-posterior diameter of ditto, 6·1 in.

Figs. 34 and 34 *a*.—Lower end of left tibia.

Length, 10·7 in. Transverse diameter of lower end, 6·5 in. Antero-posterior diameter of ditto, 4·8 in.

Figs. 35 and 35 *a*.—Lower end of right tibia.

Length, 7·5 in. Transverse diameter of lower end, 7·7 in. Antero-posterior diameter of ditto, 6· in.

Figs. 36 and 36 *a*.—Lower end of right tibia.

Length, 10·7 in. Transverse diameter of lower end, 5·6 in. Antero-posterior diameter of ditto, 4· in.

Fig. 37.—Lower articulating surface of right tibia.

Transverse diameter, 7·3 in. Antero-posterior diameter, 5·4 in.

Fig. 38.—Lower articulating surface of right tibia.

Transverse diameter, 6·1 in. Antero-posterior diameter, 5·3 in.

Fig. 39.—Lower articulating surface of left tibia.

Transverse diameter, 6·4 in. Antero-posterior diameter, 4·5 in.

Fig. 40.—Lower articulating surface of left tibia.

Transverse diameter, 6·2 in. Antero-posterior diameter, 5·4 in.

Fig. 41.—Lower articulating surface of right tibia.

Transverse diameter, 6·5 in. Antero-posterior diameter, 4·9 in.

Fig. 42.—Lower articulating surface of right tibia.

Transverse diameter, 7· in.

PLATE LIV.

Bones of posterior extremity of Proboscidea.

Figs. 1, 1 *a*, and 1 *b*.—Right calcaneum.

Length, 11· in. Height of cuboid surface, 2·6 in. Breadth of ditto, 4·2 in.

Figs. 2, 2 *a*, and 2 *b*.—Left calcaneum.

Length, 10·1 in. Height of cuboid surface, 2·6 in. Projection of calcaneum, 5·2 in. Breadth of cuboid surface, 4·2 in. Length of fibular surface, 4·2 in. Breadth of ditto, 2·3 in.

Figs. 3, 3 *a*, and 3 *b*.—Left calcaneum.

Length, 9·8 in. Height of cuboid surface, 2·8 in. Breadth of ditto, 3·9 in. Projection of heel, 4·9 in.

Figs. 4, 4 *a*, and 4 *b*.—Right calcaneum.

Length, 9·5 in. Height of cuboid surface, 3·1 in. Breadth of ditto, 3·9 in. Projection of heel, 5·3 in.

Figs. 5, 5 *a*, and 5 *b*.—Right calcaneum.

Length, 8·8 in. Projection of heel, 5·5 in.

Figs. 6, 6 *a*, and 6 *b*.—Right calcaneum.

Length, 9· in. Height of cuboid surface, 2·7 in. Breadth of ditto, 3·5 in. Projection of heel, 5·5 in.

Figs. 7, 7 *a*, and 7 *b*.—Left calcaneum, imperfect.

Length of fragment, 8·1 in. Height of cuboid surface, 2·7 in. Breadth of ditto, 3·3 in.

Figs. 8, 8 *a*, and 8 *b*.—Left calcaneum.

Length, 7·6 in. Height of cuboid surface, 3·2 in. Breadth of ditto, 2·2 in. Projection of heel, 4·9 in.

Figs. 9, 9 *a*, and 9 *b*.—Right calcaneum.

Length, 7·7 in. Projection of heel, 4·8 in.

Figs. 10, 10 *a*, and 10 *b*.—Left calcaneum.

Length, 8·4 in. Height of cuboid surface, 2·1 in. Breadth of ditto, 3·2 in.

Figs. 11, 11 *a*, and 11 *b*.—Right calcaneum.

Length, 8·5 in. Height of cuboid surface, 2·5 in. Breadth of ditto, 3·4 in. Projection of heel, 4·7 in.

Figs. 12, 12 *a*, and 12 *b*.—Left calcaneum.

Length, 7·8 in. Projection of heel, 4·5 in.

Figs. 13, 13 *a*, and 13 *b*.—Right calcaneum.

Length, 8·7 in. Height of cuboid surface, 1·8 in. Breadth of ditto, 3·4 in. Projection of heel, 5·1 in.

Figs. 14, 14 *a*, and 14 *b*.—Left calcaneum.

Length, 8·1 in. Height of cuboid surface, 2·3 in. Breadth of ditto, 3·4 in. Projection of heel, 4·7 in.

Figs. 15, 15 *a*, and 15 *b*.—Right calcaneum.

Length, 8·3 in. Height of cuboid surface, 2·2 in. Breadth of ditto, 3·1 in. Projection of heel, 4·8 in.

Figs. 16, 16 *a*, and 16 *b*.—Right calcaneum of *Mastodon Ohioticus*, imperfect.

Length of fragment, 7·7 in. Height of cuboid surface, 3·1 in. Breadth of ditto, 3·6 in. Projection of heel, wanting epiphysis, 3·6 in. Length of fibular surface, 3·8 in. Breadth of ditto, 2·1 in.

Figs. 17, 17 *a*, and 17 *b*.—Right calcaneum of Dinotherium.

Length, 13· in. Projection of heel, 6·8 in. Length of fibular surface, 4·6 in. Breadth of ditto, 2·8 in.

Figs. 18 and 18 *a*.—Left astragalus.

Figs. 19 and 19 *a*.—Right astragalus.

Length, 6·3 in. Breadth, 7· in. Thickness, 4·4 in.

Figs. 20 and 20 *a*.—Left astragalus.

Length, 4·6 in. Breadth, 4·7 in. Thickness, 3·5 in.

Figs. 21 and 21 *a*.—Left astragalus.

Length, 4·4 in. Breadth, 4·7 in. Thickness, 2·8 in.

Figs. 22 and 22 *a*.—Left astragalus.

Length, 5·5 in. Breadth, 6·4 in. Thickness, 3·8 in.

Figs. 23 and 23 *a*.—Right astragalus.

Length, 5·5 in. Breadth, 6·4 in. Thickness, 4·4 in.

Figs. 24 and 24 *a*.—Left astragalus.

Length, 4·7 in. Breadth, 5·7 in. Thickness, 3·4 in.

Figs. 25 and 25 *a*.—Right astragalus.

Length, 5·2 in. Breadth, 5·4 in. Thickness, 3·6 in.

Figs. 26 and 26 *a*.—Right astragalus.

Length, 5· in. Breadth, 6·3 in. Thickness, 3·5 in.

Figs. 27 and 27 *a*.—Left astragalus.

Length, 5·3 in. Breadth, 6·3 in. Thickness, 4· in.

Figs. 28 and 28 *a*.—Right astragalus.

Length, 4·3 in. Breadth, 4·8 in. Thickness, 3· in.

Figs. 29 and 29 *a*.—Left astragalus.

Length, 5·1 in. Breadth, 5·5 in. Thickness, 3·5 in.

Figs. 30 and 30 *a*.—Right astragalus.
Length, 5·5 in. Breadth, 6·5 in. Thickness, 4· in.

Figs. 31 and 31 *a*.—Left astragalus.
Length, 5·3 in. Breadth, 6·4 in. Thickness, 4·1 in.

Plate LV.

Bones of posterior extremity of Proboscidea.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Left calcaneum.

Length, 9·5 in. Height of cuboid surface, 2·2 in. Breadth of cuboid surface, 4· in. Projection of heel (from posterior border of surface for astragalus to most projecting part of calcaneal tuberosity) oblique, 6·2 in. Projection direct, 3· in. Height from lower surface to astragalar surface (ext.), 6· 3 in. Breadth of fibular surface, 2·5 in. Length of fibular surface, 4·2 in. Length of astragalar surface, 4·7 in. Breadth of astragalar surface 2·7 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—Left calcaneum of *Elephas antiquus*, from Grays in Essex.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Right calcaneum.

Length, 8· in. Height of cuboid surface, 2·2 in. Breadth of ditto, 3·4 in. Projection of heel (direct), 4·2 in. Height externally, 4·9 in.

Figs. 4 and 4 *a*.—Patella of *Elephas antiquus* from Grays in Essex.

Figs. 5 and 5 *a*.—Patella.
Length, 6·6 in. Breadth, 5·5 in. Thickness, 4·1 in.

Figs. 6 and 6 *a*.—Patella.
Length, 5· in. Breadth, 4·5 in. Thickness, 4· in.

Figs. 7 and 7 *a*.—Patella.
Length, 5·2 in. Breadth, 4·4 in. Thickness, 3·3 in.

Figs. 8 and 8 *a*.—Patella.
Length, 5·6 in. Breadth, 4·4 in. Thickness, 3·4 in.

Figs. 9 and 9 *a*.—Patella.
Length, 4·6 in. Breadth, 3·7 in. Thickness, 2·9 in.

Figs. 10, 10 *a*, and 10 *b*.—Left ecto-cuneiform bone.
Height, 4·3 in. Breadth, 4·5 in. Thickness, 2· in.

Figs. 11, 11 *a*, and 11 *b*.—Left ecto-cuneiform bone.
Height, 4·4 in. Breadth, 4·8 in. Thickness, 1·8 in.

Figs. 12, 12 *a*, and 12 *b*.—Left ecto-cuneiform bone.
Height, 4· in. Breadth, 3·8 in. Thickness, 1·9 in.

Figs. 13, 13 *a*, and 13 *b*.—Left ecto-cuneiform bone.
Height, 3·8 in. Breadth, 4·7 in. Thickness, 1·7 in.

Figs. 14, 14 *a*, and 14 *b*.—Right ecto-cuneiform bone.
Height, 3·9 in. Breadth, 4·4 in. Thickness, 2·1 in.

Figs. 15, 15 *a*, and 15 *b*.—Right ecto-cuneiform bone.
Height, 3·8 in. Breadth, 4·2 in. Thickness, 2·1 in.

Figs. 16, 16 *a*, and 16 *b*.—Right index metatarsal.
Length, 5·1 in. Height of posterior surface, 3· in. Breadth of ditto, 2·1 in.

Figs. 17, 17 *a*, and 17 *b*.—Right index metatarsal.
Length, 5· in. Height of posterior surface, 2·5 in. Breadth of ditto, 1·7 in.

Figs. 18, 18 *a*, and 18 *b*.—Left medius metatarsal.
Length, 4·5 in. Height of posterior surface, 1·8 in. Breadth of ditto, 2·3 in.

Figs. 19, 19 *a*, and 19 *b*.—Right index metatarsal.
Length, 5·2 in. Height of posterior surface, 2·6 in. Breadth of ditto, 1·7 in.

Figs. 20, 20 *a*, and 20 *b*.—Left medius metatarsal.
Length, 5·6 in. Height of anterior articular surface, 2·6 in. Breadth of ditto, 2·5 in.

Figs. 21, 21 *a*, and 21 *b*.—Left medius metatarsal.
Length, 5·5 in. Height of posterior surface, 2·4 in. Breadth of ditto, 2·2 in.

Figs. 22, 22 *a*, and 22 *b*.—Left medius metatarsal.
Length, 5· in. Height of posterior surface, 2·7 in. Breadth of ditto, 2·1 in.

Figs. 23, 23 *a*, and 23 *b*.—Right medius metatarsal.
Length, 5·5 in. Height of posterior surface, 3·1 in. Breadth of ditto, 2·4 in.

Figs. 24, 24 *a*, and 24 *b*.—Left annularis metatarsal.
Length, 4·3 in. Height of posterior surface, 2·4 in. Breadth of ditto, 1·7 in.

Figs. 25, 25 *a*, and 25 *b*.—Left annularis metatarsal.
Length, 5· in. Height of posterior surface, 2·7 in. Breadth of ditto, 2·5 in.

Figs. 26, 26 *a*, and 26 *b*.—Right index first phalanx.
Length, 3·5 in. Height of posterior surface, 2·8 in. Breadth of ditto, 3·3 in.

Figs. 27, 27 *a*, and 27 *b*.—Right index first phalanx.
Length, 2·8 in.

Figs. 28, 28 *a*, and 28 *b*.—Right index first phalanx.
Length, 2·2 in. Height of posterior surface, 1·7 in. Breadth of ditto, 1·9 in.

Figs. 29, 29 *a*, and 29 *b*.—Right index first phalanx.
Length, 2·9 in. Height of posterior surface, 2·1 in. Breadth of ditto, 2·8 in.

Figs. 30, 30 *a*, and 30 *b*.—Left index first phalanx.
Length, 3·3 in. Height of posterior surface, 2·5 in. Breadth of ditto, 3·2 in.

Figs. 31, 31 *a*, and 31 *b*.—Right index first phalanx.
Length, 2·5 in. Height of posterior surface, 2· in. Breadth of ditto, 2·4 in.

Figs 32, 32 *a*, and 32 *b*.—Right medius first phalanx.
Length, 2·3 in. Height of posterior surface, 1·6 in. Breadth of ditto, 2·1 in.

Figs. 33, 33 *a*, and 33 *b*.—Left annularis first phalanx.
Length, 2·7 in. Height of posterior surface, 2·1 in. Breadth of ditto, 2·5 in.

Figs. 34, 34 *a*, and 34 *b*.—Right annularis first phalanx.
Length, 3·1 in. Height of posterior surface, 2·2 in. Breadth of ditto, 2·4 in.

Figs. 35, 35 *a*, and 35 *b*.—Left annularis first phalanx.
Length, 3·5 in. Height of posterior surface, 2·3 in. Breadth of ditto, 2·9 in.

Figs. 36, 36 *a*, and 36 *b*.—Right annularis first phalanx.
Length, 4· in. Height of posterior surface, 2·9 in. Breadth of ditto, 3· in.

Plate LVI.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Elephas Namadicus*. Lower end of right femur with articulating surface. From the Valley of the Nerbudda River. This is the specimen figured by Dr. Spilsbury, in Journ. As. Soc., vol. x. p. 626, Plate A. fig. 3.—B.M.

Transverse diameter of inferior extremity, 10·7 in. Antero-posterior diameter of inner surface of ditto, 11·5 in. Antero-posterior diameter of outer surface of ditto,

9·7 in. (from posterior margins of respective condyles to anterior margins of rotular surface.). Length of rotular surface (in centre), 5·5 in. Breadth of rotular surface (in centre), 5·6 in. Circumference at commencement of fractured portion 13 in. above inferior articular surface, 22· in.

Figs. 2 and 2 *a*.—*Elephas Namadicus*. Lower end of right tibia, with articular surface; from the Nerbudda.—B.M.

Greatest transverse diameter of inferior extremity, 7·4 in. Greatest antero-posterior diameter of ditto, 6·1 in. Projection downwards of the internal malleolus, 1·4 in. Circumference at broken end 9 in. above inferior surface, 12·6 in.

Figs. 3 and 3 *a*.—*Elephas Namadicus*. Upper end of right radius; from the Nerbudda.—B.M.

Greatest transverse diameter, 6·2 in. Greatest antero-posterior diameter, 3·8 in.

Figs. 4, 4 *a*, and 4 *b*.—*Elephas Namadicus*. Dorsal vertebra; from the Nerbudda.—B.M.

Height of body, anteriorly, 5·8 in. Breadth of body, anteriorly, 5·6 in. Length of body, inferiorly, 2·4 in. Spinal canal, height, anteriorly, 2· in. Spinal canal, breadth, anteriorly, 3· in. Between extreme points of transverse processes, 12·8 in. Anterior costal surface, height, 2·6 in. Anterior costal surface, breadth, 1·8 in.

Fig. 5.—*Elephas Namadicus*. Left femur in three fragments. This figure is copied from an illustration of Mr. J. Prinsep's description of a fossil found by Dr. Spilsbury in the Nerbudda Valley, near Narsinhpoor (Journ. As. Soc., Aug. 1834, vol. iii. p. 396, Plate XXIV. fig. 3). The dimensions of the femur, while it remained whole and attached to the rocky matrix, were as follows:—

Greatest length, 63· in. Circumference of the head, 27· in.; diameter of ditto, 8·75 in. Breadth from tip of great trochanter to inner edge of head, 18· in. Circumference of shaft at centre, 19· in. Breadth of condyles, 11· in.

Fig. 6.—*Elephas Namadicus*. Fragments of right femur. The epiphysis of the head is lost, but its place is shown by a dotted line. This figure is copied from the same source as the last. (Journ. As. Soc., vol. iii. Plate XXIV. figs. 9 and 10. Fig. 6 *a*. is lower end of the left femur represented in fig. 5, and not of that in fig. 6, as might be inferred from dotted line in Plate.

Fig. 7.—*Elephas Namadicus*. Humerus; copied from the illustration of a paper by Dr. Spilsbury in Journ. As. Soc., June 1837, vol. vi. p. 487, Plate XXX. fig. 1.

Fig. 8.—*Elephas Namadicus*. Bones of pelvis with acetabulum, copied from same source as fig. 7. (Plate XXX. figs. 5 and 6.)

Fig. 9.—*Elephas Namadicus*. Lower jaw, with molar incomplete at left side. This specimen is also copied from an illustration of Mr. J. Prinsep's description of a fossil found by Dr. Spilsbury in the Nerbudda Valley (Journ. As. Soc., Nov. 1833, vol. ii. p. 583, Plate XX. fig. 1). The jaw is inverted in the drawing.

Length of tooth, 11·5 in. Breadth, 3·5 in. Length of grinding surface, 8·5 in. Girth of jaw-bone, 24· in. Probable length from chin to condyle, 26· in.

A description of the locality where the Nerbudda fossils were found, with sectional drawings, will be found in the paper above referred to.

Figs. 10 and 10 *a*.—*Elephas insignis*. Fragment of molar showing four plates. The specimen is remarkable as coming from the Valley of the Nerbudda.—B.M.

Length of molar, 4·7 in. Greatest breadth, 3·1 in. Height of fragment, 6· in.

Figs. 11 and 11 *a*.—*Elephas insignis*. Fragment of molar, remarkable as coming from the Valley of the Nerbudda.—B.M.

Length of fragment of grinding surface, 2·5 in. Breadth of tooth at centre of that fragment, 3· in.

Figs. 12 and 12 *a*—*Elephas* ——? Fragment of molar containing about nine plates; from the Nerbudda.—B.M.

Length, 5·2 in. Breadth, 2·3 in.

Figs. 13 and 13 *a*.—*Elephas* ——? Fragment of lower jaw, containing portion of molar with about seven plates; from the Nerbudda. —B.M.

Length of fragment of jaw, 11·3 in. Greatest breadth of ditto, 5·2 in. Height opposite posterior border of molar, 4·5 in. Length of tooth, 5·5 in. Greatest breadth of ditto, 2·7 in.

Figs. 14, 14 *a*, and 14 *b*.—*Elephas* ——? Fragment of molar with six plates; from the Nerbudda.—B.M.

Length, 6·4 in. Breadth, 4·1 in.

Plate LVII.

Fig. 1.—*Hippopotamus* (*Tetraprotodon*) *Palæindicus*. (Falc. and Caut.) Almost entire skull, viewed from above, with zygomatic arches complete. Specimen from the Nerbudda in B.M. It shows well the great saliency of the sagittal crest. There is a finer specimen in the Museum of the Asiatic Society of Bengal (See *antea*, p. 147).

Fig. 1 *a*.—Lateral view of same skull, showing cavity of orbit, &c. The great projection of the orbit above the plane of the frontal, characteristic of the species, is well seen.

Fig. 1 *b*.—Same skull, palatine view, showing three molars, the furthest back intact, the two next ground down; also the three premolars on one side, and two on the other.

Fig. 1 *c*.—Occipital view of same skull, showing condyles and foramen magnum, and the great saliency of the occipital crest.

Figs. 2 and 2 *a*.—*H. Palæindicus*. Portion of upper jaw, right side, with three molars.—B.M.

Figs. 3 and 3 *a*.—*H. Palæindicus*. Portion of lower jaw, with teeth.—B.M.

Fig. 4.—*H. Palæindicus*. Fragment of canine.—B.M.

Figs. 5 and 5 *a*.—*H. Palæindicus*. Anterior portion of jaw with alveoli of *four* incisors. The diameter of the alveoli of the central incisors is much less than that of the external incisors—a fact which refutes De Blainville's opinion that the Nerbudda Tetaprotodon is identical with the living African species. In the latter the middle incisors are the largest.

Figs. 6 and 6 *a*.—*H. Palæindicus*. Portion of lower jaw, with grinders (three molars and two premolars) worn down.—B.M.

Figs. 7 and 7 *a*.—*H. Palæindicus*. Portion of lower jaw, with two molars.—B.M.

Fig. 8.—*H. Palæindicus.* Lower canine.—B.M.

Fig. 8 *a.*—*H. Palæindicus.* Transverse section of canine, of ovoid shape.

Fig. 9.—*H. Palæindicus.* Last lumbar vertebra. Anterior view.—B.M.

Fig. 9 *a.*—*H. Palæindicus.* Last lumbar vertebra. Viewed from above.

Fig. 9 *b.*—*H. Palæindicus.* Last lumbar vertebra. Lateral view.

Figs. 10, 10 *a*, 10 *b*, and 10 *c.*—*Hippopotamus* (*Hexaprotodon*) *Iravaticus* (Falc. and Caut.), from Ava. Anterior portion of the lower jaw, different views. Shows the six incisor teeth characteristic of the subgenus.—B.M.

Figs. 11 and 11 *a.*—*H. Iravaticus.* Fragment of jaw with alveoli, &c.

Figs. 12 and 12 *a.*—*Hippopotamus* (*Hexaprotodon*) *Namadicus.* From the Nerbudda. Anterior portion of lower jaw, showing the six incisors.

PLATE LVIII.

Fig. 1.—*Hippopotamus* (*Hexaprotodon*) *Namadicus* (Falc. and Caut.), from the Nerbudda. Lower jaw, viewed from above, showing molars, canines, and *six* incisors.—B.M.

Fig. 1 *a.*—*Hippopotamus* (*Hexaprotodon*) *Namadicus.* Right lateral view of same specimen.

Fig. 2.—*H. Namadicus.* Lower jaw, viewed from above. Showing molars and premolars complete on left side, with portions of both canines and of right outer incisor; also alveoli of five remaining incisors.—B.M.

Fig. 2 *b.*—*H. Namadicus.* Lateral view of same specimen.

Fig. 3.—*H. Namadicus.* Fragment of lower jaw viewed from above, showing molars and premolars on one side, and portions of left canine and all six incisors.—B.M.

Fig. 3 *b.*—*H. Namadicus.* Lateral view of same specimen.

Fig. 4.—*Hippopotamus* (*Tetraprotodon*) *Palæindicus.* Fine specimen of skull, incomplete; upper surface showing the zygomatic arches, and the great prominence of the sagittal ridge. There is a still more perfect specimen in the Museum of the Asiatic Society of Bengal (See *antea*, p. 147).—B.M.

Fig. 4 *a.*—*Hippopotamus* (*Tetraprotodon*) *Palæindicus.* Lateral view of same specimen, showing the great projection of the orbit above the plane of the frontal.

Fig. 4 *b.*—*Hippopotamus* (*Tetraprotodon*) *Palæindicus.* Palatine view of same specimen, showing the three molars on both sides, well ground down, and the left posterior premolar.

Figs. 5, 5 *a*, 5 *b*, and 5 *c.*—*Hippopotamus Palæindicus.* Four different views of first dorsal vertebra.—B.M.

Fig. 6.—*H. Palæindicus.* Head, neck, and upper portion of shaft of left femur, anterior view.—B.M.

Fig. 6 *a.*—*H. Palæindicus.* Posterior view of same specimen.

Fig. 6 *b*.—*H. Palæindicus*. Same specimen viewed from above.

Fig. 7.—*H. Palæindicus*. Lower end of shaft, with articulating extremity, of femur, posterior view.—B.M.

Fig. 7 *a*.—*H. Palæindicus*. Posterior view of same specimen.

Fig. 7 *b*.—*H. Palæindicus*. Same specimen viewed from below.

Figs. 8, 8 *a*, and 8 *b*.—*H. Palæindicus*. Upper end of tibia. Anterior, posterior, and upper views.—B.M.

Figs. 9, 9 *a*, 9 *b*, and 9 *c*.—*H. Palæindicus*. Entire tibia. Anterior, posterior, upper and lower views.—B.M.

Figs. 10, 10 *a*, 10 *b*, and 10 *c*.—*H. Palæindicus*. Entire radius. Anterior, posterior, upper and lower views.—B.M.

Plate LIX.

Fig. 1.—*Hippopotamus* (*Hexaprotodon*) *Sivalensis*. (Falc. and Caut.) Fine specimen of entire skull from the Sewalik hills. Upper surface, showing the zygomatic arches, sagittal crest, and muzzle. The hollow between the muzzle and the zygomatic arch is remarkably abrupt, and the occipital crest is very elevated.—B.M. (See *antea*, p. 142.)

Fig. 1 *a*.—*H. Sivalensis*. Palatine view of same specimen, showing the three molars and four premolars, well ground, and the alveoli of the canines and *six* incisors. The line of molars is seen to curve slightly outwards towards the front and also behind. The space between the most advanced molar and the canine is much shorter than in the existing animal. There is a deep fissure in front between the incisive bones.

Fig. 1 *b*.—*H. Sivalensis*. Lateral view. The orbit projects but slightly above the plane of the frontal, and in this respect the species contrasts remarkably with that of the *H. Palæindicus*, Plate LVII. fig. 1 *a*, and Plate LVIII. fig. 4 *a*. The orbit is also much more advanced than in the existing Hippopotamus, and this accounts for the abrupt hollow between the muzzle and zygomatic arch. The incisors, drawn in outline, are seen to curve downwards. (Reproduced in Pl. XI. figs. 1, 2, and 3.)

Fig. 2.—*H. Sivalensis*. Another specimen of cranium, upper surface. The right zygomatic arch is imperfect; the nasal sutures are more distinct than in fig. 1.—B.M.

Fig. 2 *a*.—*H. Sivalensis*. Palate view of same specimen, showing three molars and four premolars on either side. Posteriorly the molar lines curve less out than in fig. 1, and the teeth are somewhat less worn.

Fig. 3.—*H. Sivalensis*. Another specimen of cranium, upper surface. Both zygomatic arches are imperfect.—B.M.

Fig. 3 *a*.—*H. Sivalensis*. Palate view of same specimen, showing three molars and four premolars on either side. The teeth are less ground than in figs. 1 and 2. The trefoil wear of the coronals of each pair of collines is well seen.

Plate LX.

Fig. 1.—*H. Sivalensis.* Fragment of posterior portion of skull; upper surface; showing occipital ridge and left zygomatic arch.—B.M.

Fig. 1 *a*.—Under surface of same specimen.

Fig. 1 *b*.—Lateral view of same specimen.

Fig. 2.—*H. Sivalensis.* Fine specimen of cranium, with occipital ridge, and nasal sutures distinct, and both zygomatic arches intact.—B.M.

Fig. 2 *a*.—Lateral view of same specimen, showing lower jaw *in situ*. The slight elevation of the orbit above the plane of the frontal is also seen.

Fig. 2 *b*.—Posterior view of same specimen, showing occipital ridge, condyles, and foramen magnum.

Fig. 3.—*H. Sivalensis.* Fragment of posterior part of another skull with both zygomatic arches.—B.M.

Fig. 3 *a*.—Palatine view of same specimen, showing posterior and part of middle molar, on either side.

Fig. 3 *b*.—Lateral view of same specimen.

Fig. 3 *c*.—Occipital, or posterior, view of same specimen.

Fig. 4.—*H. Sivalensis.* Another specimen of cranium deficient in muzzle and right zygomatic arch; upper surface.

Fig. 4 *a*.—Palatine view of same specimen, showing three molars and one premolar, on either side, much worn.

Fig. 4 *b*.—Lateral view of same specimen, showing the slight elevation of the orbit.

Fig. 4 *c*.—Posterior, or occipital, view of same specimen.

Plate LXI.

Fig. 1.—*H. Sivalensis.* Fragment of young skull, showing muzzle; under surface showing molars and canines and alveoli of premolars.—B.M.

Fig. 1 *a*.—Upper surface of same specimen.

Fig. 1 *b*.—Same specimen; lateral view.

Fig. 2.—*Hippopotamus Sivalensis.* Skull, imperfect; palatal view.—B.M.

Fig. 2 *a*.—Lateral view of same specimen.

Fig. 3.—*H. Sivalensis.* Fragment of lower jaw, right side, viewed from above. The molar line is seen to curve outwards, both in front and behind, as in the upper jaw.

Fig. 3 *a*.—Lateral view of same fragment. The condyle, coronoid process, and the descending process are broken off. The lower margin is straight.

Figs. 4 and 4 *a*.—*H. Sivalensis.* Fragment of lower jaw, upper and lateral surface. The alveolar ridge on right side is very perfect, and

shows three molars and three premolars, with a portion of the canine. The condyle, coronoid process, and descending process are wanting. The lower margin is straight.—B.M.

Figs. 5 and 5 *a*.—*H. Sivalensis*. Lower jaw, more perfect; viewed from above and also laterally. The alveolar ridges on both sides are perfect, and comprise three molars and three premolars, and also the alveolus of a fourth premolar. Both canines are broken off; but the right one is tolerably perfect, and is seen to curve back slightly at its tip. The incisive ridge is perfect, but the teeth are wanting. The width across the muzzle from the outer side of one canine alveolus to that of the other is greater, and the width of the jaw over the penultimate false molar is less, than in *H. amphibius*. The condyle, coronoid process, and descending ramus are wanting. The lower margin is straight.—B.M.

Figs. 6 and 6 *a*.—*H. Sivalensis*. Lower jaw, viewed from above and also laterally. The posterior molars on both sides are wanting; but the two anterior molars and three premolars, on either side, and the two canines and *six* incisors are present. The space between the anterior premolar and the canine is very contracted. The right canine is very perfect. The anterior angle of the jaw below the canines is more abrupt, and the depth of the body of the jaw more regular, than in *H. amphibius*. The coronoid process is present, but the condyle and descending portion are wanting. The coronoid process is not projected so much forward as in *H. amphibius*.

Figs. 7 and 7 *a*.—*H. Sivalensis*. Fragment showing symphysis of lower jaw, with canines and incisors remarkably perfect. The horizontal direction of the *six* incisors and the peculiar curve of the canines upwards and slightly backwards are well seen. The incisors are of nearly equal dimensions, and the two central ones are not larger, as in *H. amphibius*; they are cylindrical, and inclined outwards at an obtuse angle to the plane of the grinding surface; their ends are truncated. They are much larger than in the specimen shown in fig. 6, so that the animal was probably an adult male.—B.M. (Reproduced in Pl. XII. figs. 2 and 3.)

Fig. 8.—*H. Sivalensis*. Large descending process of ramus of lower jaw, detached. This remarkable appendage for the attachment of the masseter and temporal muscles, peculiar to the genus, is even more developed than in *H. amphibius*; it is less tapering and more deep and massive in its proportions; the posterior margin is more round, and the anterior, which in *H. amphibius* is curved and pointed forwards, is here blunt and unmarked by any peculiarity of form. The process is inclined outwards, and its outer surface is as marked for the reception of muscles as in the living Hippopotamus.—B.M.

Fig. 9.—*H. Sivalensis*. Another specimen of descending process of ramus of lower jaw. (Reproduced in Pl. XII. fig. 4.)

Fig. 10.—Anterior portion of palate, with *six* incisors, and with three premolars on right side, and two on left.—B.M.

Figs. 11 and 11 *a*.—Anterior portion of palate with canine and two premolars; viewed from above, and also laterally.—B.M.

Plate LXII.

Fig. 1.—*Hippopotamus* (*Hexaprotodon*) *Sivalensis*. Left side of lower jaw, viewed from above, with three molars and the three posterior premolars. The trefoil wear of the coronals of each pair of collines is well seen. The fragment is broken off in front of the second premolar. The drawing shows the descending process of the jaw. (Reproduced in Pl. XII. fig. 1.)

Fig. 2.—*H. Sivalensis*. Right side of lower jaw, with three molars and four premolars. The specimen is remarkable as showing the first or foremost premolar, which in most of the specimens is wanting. The canine is absent, but the three right incisors are present. The teeth are less worn than in fig. 1, the posterior molar being intact.—B.M.

Fig. 3.—*H. Sivalensis*. Left side of lower jaw, viewed from above, showing the two anterior molars, and a portion of the third or posterior molar; also the four premolars, the fourth or posterior one being very small. Both the molars and premolars are well ground, so that the animal was probably old. The specimen also shows the canine tooth broken off, and the alveoli of the three left incisors.—B.M.

Fig. 4.—*H. Sivalensis*. Anterior margin of lower jaw, showing the six incisors, all about the same size, with the two canines incomplete. —B.M.

Fig. 4 *a*.—*H. Sivalensis*. Vertical section from side to side through anterior portion of lower jaw, with sections through the six incisors and two canines, showing the relative position of their alveoli.—B.M.

Fig. 5.—*H. Sivalensis*. Premolar from lower jaw.—B.M.

Fig. 6.—*H. Sivalensis*. Premolar from lower jaw.—B.M.

Figs. 7, 7 *a*, and 7 *b*.—*H. Sivalensis*. Upper canine deeply grooved along posterior surface and obliquely truncated in front. The transverse section (7 *b*) presents a reniform outline.—B.M.

Figs. 8 and 8 *a*.—*H. Sivalensis*. Fragment of upper canine with truncated anterior extremity and reniform outline on section.—B.M.

Figs. 9 and 9 *a*.—*H. Sivalensis*. Fragment of upper canine, with truncated anterior extremity and reniform outline on section.

Fig. 10.—*H. Sivalensis*. Lower canine, curved upwards and slightly backwards at tip. The point obliquely truncated on its posterior surface. The form of the tooth is such as to present a pyriform outline when cut across.—B.M.

Fig. 11.—*Hippopotamus* (*Tetraprotodon*) *Palæindicus*. Fragment of lower jaw, right side, with three molars and the three posterior premolars. The hindmost molar is intact; those in front are moderately worn. The fourth or hindmost premolar is very small—deciduous. —B.M.

Fig. 12.—*H. Palæindicus*. Fragment of lower jaw, with three molars and three posterior premolars. The teeth are more ground than in fig. 11.

Figs. 13 and 13 *a*.—*Hippopotamus* (*Tetraprotodon*) *major*. Upper canine, obliquely truncated at front, with cordate outline on section.

Figs. 14 and 14 *a*.—*Hippopotamus* (*Tetraprotodon*) *amphibius*. Upper canine, truncated in front, with reniform outline on section.

Fig. 15.—*Merycopotamus dissimilis*. (Falc. and Caut.) Lower jaw, right side, with three molars, four premolars, portion of canine, and alveoli of incisors. The teeth exhibit a ruminant-like pattern of wear in the crown which is characteristic of the genus.

Fig. 16.—*Merycopotamus dissimilis*. Lower jaw, right side. Larger specimen than fig. 15, with three molars, fourth molar, and canine. The alveoli of three anterior premolars and three incisors are seen. —B.M.

Figs. 17 and 17 *a*.—*Merycopotamus dissimilis*. Molars showing well the rugous surface of the enamel, the basal cingulum, and the ruminant-like pattern of wear characteristic of the genus.—B.M.

Fig. 18.—*Merycopotamus dissimilis*. Molar.

Figs. 19, 19 *a*, and 19 *b*.—This tooth was found in the Kalowala Pass by Capt. (now Sir Proby) Cautley, and is figured by Royle in 'Illustrations of Botany of the Himalayah Mountains' (vol. ii. Plate III. figs. 12, 13, 14, and 15), as the tooth of an *Anthracotherium*. In several of Dr. Falconer's published papers reference is made to the occurrence of Anthracotherium among the Sewalik fossils (See Synopsis of Sewalik Fossils, in Journ. As. Soc., vol. iv. p. 706, and first paper on Monkey, *antea*, p. 296; and also *note*, p. 508.) The specimen, however, is not named on the Plate, and differs from Anthracotherium.—B.M.

Plate LXIII.

Vertebræ of *Hippopotamus* (*Hexaprotodon*) *Sivalensis*.

Figs. 1 and 1 *a*.—Seven cervical vertebræ in position, viewed anteriorly and laterally.

Figs. 2, 2 *a*, and 2 *b*.—Atlas. Upper, lower, and anterior views. —B.M.

Figs. 3, 3 *a*, and 3 *b*.—Atlas. Upper, lower, and lateral views.—B.M.

Figs. 4, 4 *a*, and 4 *b*.—Atlas. Upper, lower, and anterior views.—B.M.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Axis. Four different views.—B.M.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Axis. Four different views.—B.M.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Axis. Four different views.—B.M.

Figs. 8 and 8 *a*.—Axis. Anterior and lateral views.—B.M.

Figs. 9 and 9 *a*.—Axis. Anterior and lateral views.—B.M.

Figs. 10 and 10 *a*.—Axis? Upper and lateral views.—B.M.

Figs. 11, 11 *a*, and 11 *b*.—Sixth? cervical vertebra. Upper, lower, and lateral views.—B.M.

Figs. 12, 12 *a*, and 12 *b*.—Third cervical vertebra. Upper lower, and lateral views.—B.M.

Plate LXIV.

Hippopotamus (*Hexaprotodon*) *Sivalensis.*

Figs. 1 to 12.—Vertebræ, mainly dorsal and lumbar. Fig. 1 is a cervical vertebra; fig. 2 is the 5th cervical; fig. 3 is an anterior (1st?) dorsal (see *antea*, p. 146); fig. 4 is the second dorsal; fig. 5 is the fourth dorsal; fig. 6 is the second dorsal; fig. 7 is the fifth dorsal; fig. 8 is the seventh dorsal; fig. 9 is the fourth and fifth dorsals, united, with a fragment of rib on each side; fig. 10 is the eighth dorsal; and figs. 11 and 12 are lumbar vertebræ.—B.M.

Figs. 13, 13 *a*, 14, and 14 *a*.—Bones of sacrum, different views.—B.M.

Figs. 15, 15 *a*, and 15 *b*.—Sacrum. Anterior and lateral view.—B.M.

Fig. 16.—Fragment of ilium.—B.M.

Figs. 17 and 17 *a*.—Portion of pelvis, showing acetabulum. Two different views.—B.M.

Figs. 18 and 18 *a*.—Portion of pelvis, showing acetabulum. Two different views.—B.M.

Plate LXV.

Hippopotamus (*Hexaprotodon*) *Sivalensis.* Bones of the anterior extremity.

Figs. 1, 1 *a*, and 1 *b*.—Fragment of scapula, three different views, showing spine, upper margin, and glenoid cavity.—B.M.

Figs. 2 and 2 *a*.—Fragment of scapula, less perfect, showing spine and glenoid cavity.—B.M.

Figs. 3 and 3 *a*.—Fragment of scapula with spine and glenoid cavity.—B.M.

Figs. 4 and 4 *a*.—Fragment of scapula with spine and glenoid cavity.—B.M.

Fig. 5.—Glenoid cavity of scapula.—B.M.

Figs. 6 to 8.—Three specimens of upper articulating extremity of humerus; three views of each.—B.M.

Figs. 9 and 9 *a*.—Shows the bones of the elbow joint, the lower end of the humerus, and the upper end of the radius and ulna.—B.M.

Figs. 10 to 13.—Show four different specimens of lower end of humerus; three views of each specimen.—B.M.

Figs. 14 and 15.—Two fragments showing upper articulating end of ulna; two views of each.—B.M.

Figs. 16, 16 *a*, 16 *b*, and 16 *c*.—Single bone of fore-arm, nearly perfect.—B.M.

Figs. 17 and 17 *a*.—Upper end of fore-arm.—B.M.

Fig. 18.—Lower end of fore-arm.—B.M.

Figs. 19 and 19 *a*.—Lower end of radius and ulna, with bones of carpus:—*a*. scaphoid; *b*. semilunar; *c*. cuneiform; *d*. pisiform in

outline; *e.* trapezium in outline; *f.* trapezoid in outline; *g.* os magnum in outline; *h.* cuneiform in outline.—B.M.

Figs. 20, 20 *a*, and 20 *b*.—Lower end of radius and ulna.—B.M.

Fig. 21.—Carpal bones *in situ*:—*a.* scaphoid; *b.* semilunar in outline; *c.* cuneiform; *f.* trapezoid in outline; *g.* os magnum; *h.* cuneiform.

Figs. 22 to 26.—Carpal bones detached; three views of each.

Fig. 22.—Right scaphoid.—B.M.

Fig. 23.—Right semilunar.

Fig. 24.—Right cuneiform.—B.M.

Fig. 25.—Right os magnum.—B.M.

Fig. 26.—Right cuneiform.

Figs. 27 to 32.—Metacarpal bones and phalanges.—B.M.

Figs. 33, 33 *a*, and 33 *b*.—Lower end of united radius and ulna, right side. This specimen is remarkable, as being from Ava.—B.M.

PLATE LXVI.

Hippopotamus (*Hexaprotodon*) *Sivalensis*. Bones of posterior extremity.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Left femur, entire.—B.M.

Figs. 2, 2 *a*, and 2 *b*.—Upper end of left femur.—B.M.

Figs. 3, 3 *a*, and 3 *b*.—Upper end of right femur.—B.M.

Figs. 4, 5, and 6.—Three fragments showing lower end of femur; three views of each specimen.—B.M.

Figs. 7, 8, and 9.—Three patellæ; two views of each.—B.M.

Figs. 10, 11, and 12.—Fragments showing upper extremity of tibia; three views of each.—B.M.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Entire tibia.—B.M.

Figs. 14, 15, 16, and 17.—Fragments showing lower end of tibia; three views of each.—B.M.

Figs. 18 and 18 *a*.—Lower end of tibia and fibula, with bones of tarsus:—*a.* astragalus; *c.* calcaneum; *e.* scaphoid.

Figs. 19 and 19 *a*.—Calcaneum.—B.M.

Figs. 20 to 25.—Bones of tarsus, detached.—B.M.

Figs. 20, 21, 22, 23, and 24.—Represent different specimens of astragalus; three views of each.

Figs. 25, 25 *a*, and 25 *b*.—Left cuboid bone.

Figs. 26, 26 *a*, 26 *b*, 27, and 27 *a*.—Metatarsal bones.—B.M.

PLATE LXVII.

Merycopotamus dissimilis. (Falc. and Caut.)

Fig. 1.—Var. *major*.[1] Upper surface of cranium, the anterior portion, or muzzle, broken off.—B.M.

[1] See page 138, *note*.

Fig. 1 *a*.—Lateral view of same specimen. The orbit is not elevated above the plane of the frontal.

Fig. 1 *b*.—Palatine view of same specimen, showing three molars and one premolar. The absence of the trefoil wear of the coronals is to be noted. Each pair of collines takes a crescentic form outwards, not unlike that of ruminants, and the grinding surface slopes outwards, as in the description given by Cuvier of *Hippopotamus minutus*.[1]

Fig. 1 *c*.—Posterior or occipital view of same specimen.

Figs. 2, 2 *a*, and 2 *b*.—*M. dissimilis* (var. *major*). Imperfect cranium including muzzle. Lateral, upper, and palatal views.—B.M.

Figs. 3, 3 *a*, and 3 *b*.—*M. dissimilis* (var. *major*). Cranium; upper, palatine, and lateral views, showing three molars, four premolars, and canines. The second left and first right premolars have dropped out. The left canine is seen to be remarkably curved downwards, first outwards and forwards, and then slightly backwards.—B.M. (Reproduced in Pl. XIII. figs. 1 and 2.)

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—*M. dissimilis* (var. *major*). Lower jaw, right side; outer, upper, and inner views. The alveoli of three incisors and first three premolars are empty; the three molars and fourth premolar are present, but, excepting hindmost molar, are well worn; the canine is curved upwards and outwards and slightly backwards at the tip; it is pear-shaped on section, as in *Hipp. Sivalensis*. The descending process is well seen, and is separated from the horizontal ramus by a considerable indentation. The anterior extremity of the horizontal ramus is much more oblique than in *H. Sivalensis*, and the junction of the lower with the anterior margin, corresponding to the lower end of the symphysis, is marked by a distinct tuberosity or projection downwards (*x*). One large mentary foramen is seen on outer surface below the fourth molar, and between this and the canine the bone is deeply channelled; the molar ridges are almost parallel, and there is very little widening of the symphysial portion of the jaw. The great peculiarity of the jaw is the general slenderness of its proportions and the inequality of its depth. From the descending process it first becomes deeper, and then it gradually diminishes towards the symphysis. In *Hipp. Sivalensis* the jaw is straight, thick, and massive, as in Plate LXI. 3, 4, 5.—B.M. (Reproduced in Pl. XIII. figs. 3 and 4.)

Figs. 5, 5 *a*, and 5 *b*.—*M. dissimilis* (var. *minor*?). Cranium; upper,

[1] 'In the true molars of the *Merycopotamus*, the inner demi-cones are simply convex, and the two grooves on the outer ares form a deep external depression, at the bottom of which is the convex ridge. The antero-posterior cleft, instead of being straight, as in the Hippopotamus, forms two bends convex inwards, and thus the symmetrical pattern of the Hippopotamic molar is converted into the double-crescentic arc of the Ruminant molar. The cement at the bottom of the valleys is thinner than in the Ruminants; the enamel is as rugose as in the Giraffe or Sivathere; but the strong ragged ridge along the inner half of the base of the crown forms the chief distinction between the molars of the Merycopotamus and those of the Ruminant. The teeth in the lower jaw make a similar approximation to the Ruminant type, but the anterior and posterior primary divisions are separated by a wider cleft; the last molar has a third hinder lobe; the lower molars are implanted by two roots. The forms, proportions, and relative position of the canines and incisors closely accord with the Hippopotamic type of these teeth.' Owen's 'Odontography,' i. 566.

palatine, and lateral views. The left zygomatic arch is almost complete; the right is absent. The molars, premolars, and right canine are well seen; the incisor ridge is mutilated. The molar ridges are parallel; the whole jaw tapers forward, and there is no widening of its anterior extremity, and no abrupt angle between the line of the jaw and the zygomatic arch.—B.M.

Fig. 6.—*M. dissimilis* (var. *minor*?). Lower jaw, right side, comprising the horizontal and part of the ascending ramus, with the expanded disc below. The three molars are *in situ*. The premolars have dropped out, but their alveoli are seen. The canine is also *in situ*, but broken off. The molars in the original exhibit well the rugous surface of the enamel, with the basal cingulum and the ruminant-like pattern of wear on the crown which are characteristic of the genus, which is nearly allied to Anthracotherium in the teeth. The colline apices of the molars are more widely separated than in other Hippopotami. The specimen from which this figure is taken is in the Museum of the Asiatic Society at Calcutta (Sewalik series, No. 246), and is described by Dr. Falconer in the Catalogue of the Museum. See *antea*, p. 146.—Cast in B.M.

Figs. 7, 7 *a*, and 7 *b*.—(Var. *minor*?). Fragment of lower jaw, right side, with molars and premolars *in situ*. The alveoli of the canine and three incisors are seen in the broken surface in front. The ascending ramus and descending process are broken off. The large mentary foramen and deep channel in front are very distinct.—B.M.

Figs. 8 and 8 *a*.—*M. dissimilis*. Fragment of anterior portion of lower jaw, left side, with very perfect canine.

Plate LXVIII.

Figs. 1 to 18.—*Merycopotamus dissimilis*.

Figs. 1 and 2.—Two fragments of pelvis with acetabulum; two views of each.—B.M.

Figs. 3, 3 *a*, and 3 *b*.—Upper end of right femur.—B.M.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—Lower end of femur.—B.M.

Figs. 5, 5 *a*, and 5 *b*.—Upper end of tibia.—B.M.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Fragment of calcaneum.—B.M.

Figs. 7, 7 *a*, 7 *b*, 7 *c*, and 7 *d*.—Calcaneum.—B.M.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—Calcaneum.—B.M.

Figs. 9, 9 *a*, 9 *b*, 9 *c*, and 9 *d*.—Astragalus.—B.M.

Fig. 10.—Calcaneum and astragalus *in situ*.

Figs. 11 and 12.—Two specimens of upper end of humerus; three views.—B.M.

Figs. 13, 13 *a*, 13 *b*, 13 *c*, and 13 *d*.—Lower end of humerus.—B.M.

Figs. 14, 14 *a*, 14 *b*, and 14 *c*.—Four different views of radius of *Merycopotamus dissimilis*.—B.M.

Fig. 15.—Fragment of occiput, showing condyles and occipital crest.—B.M.

Fig. 16.—Fragment of lower jaw.

Figs. 17 and 17 *a*.—Lower jaw, anterior portion, both sides, showing absence of any widening of symphysis.—B.M.

Figs. 18 and 18 *a*.—Incisive ridge.—B.M.

Figs. 19, 19 *a*, 19 *b*, and 19 *c*.—*Hipp. Sivalensis*. Calcaneum.—B.M.

Figs. 20, 20 *a*, and 20 *b*.—*Hipp. Sivalensis*. Astragalus.—B.M.

Fig. 21.—*Hipp. Sivalensis*. Calcaneum and astragalus, placed *in situ*.

Figs. 22 and 22 *a*.—*Anthracotherium Silistrense*. Molars in Museum Geol. Soc.

Figs. 23 and 23 *a*.—*Anthracotherium Silistrense*. Molars in Museum Geol. Soc.

Fig. 24.—*Anthracotherium Velaunum*. Molars in Mus. Geol. Soc.

Fig. 25.—*Anthracotherium Velaunum*. Molars in Mus. Geol. Soc.

The Anthracotherium, like the closely allied Merycopotamus, formed a link connecting the Hippopotamus with the Ruminants. The molars, however, depart less from the Hippopotamic type than in Merycopotamus.[1]

Plate LXIX.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Sus giganteus* (Falc. and Caut.). Upper, palatal, lateral, and occipital views of skull. The zygomatic arches are perfect. There are three molars on either side, and also the last premolar. The specimen is broken off in front of the last premolar. The extreme distance between the zygomata is much greater than in *Sus scrofa*. The sub-orbital foramina are large, and the bone is deeply channelled in front. From the Sewalik hills.—B.M.

Length of fragment, 11·7 in. Between the most distant points of the zygomata, 8·5 in. Between the post-orbital processes, 5·1 in. Least breadth of cranium between temporal fossæ, 1·1 in. Height of occipital facet from lower border of occipital foramen, 6·5 in. Height of occipital foramen, ·9 in. Breadth of ditto, 1· in. Breadth of occipital condyle, 1·3 in. From lower border of occipital foramen to posterior border of palate, 3·8 in. Height of cranium at sub-orbital foramen from palate, 3·1 in. Breadth of ditto superiorly, 2·4 in. Least breadth of occipital facet, 3·5 in. Width of posterior nares, ·7 in. Length of three true molars, 3·2 in. Of ditto, including last premolar, 3·7 in. Width of palate, posteriorly, 1·7 in. Of ditto, anteriorly, 1·5 in. Greatest breadth of alveoli, 1·3 in. Height of posterior nares, 1·7 in. Greatest diameter of orbit, 1·7 in.

Figs. 2, 2 *a*, and 2 *b*.—*Sus giganteus*. Fragment showing anterior portion of skull broken off about the line of the sub-orbital foramina. Upper, lateral, and palatine views. The three molars and two last premolars are well seen, and are less ground than in fig. 1.—B.M.

Length of fragment, 9· in. Width superiorly at sub-orbital foramen, 2·2 in. Height, from palate, 4· in. Length of three true molars, 3·7 in. Of ditto, including two last premolars, 5·1 in. Width of palate posteriorly, 1·6 in. Of ditto, anteriorly, 1·4 in. Greatest width of alveoli, 1·3 in.

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[1] Dr. F. was at one time inclined to regard the Merycopotamus as identical in genus with the *Anthracotherium Velaunum* of Cuvier. On Dec. 6, 1843, he wrote thus to Capt. Cautley: 'What do you think! Our *Hippo. dissimilis* is identical in genus with Cuvier's *Anthracotherium Velaunum*; that is to say, he misnamed his specimen from imperfect materials. I have had the two heads chiselled out, and intend describing them under the name of a new genus *Merycopotamus* (*merico*, from the resemblance of the teeth to those of a Ruminant).'

Figs. 3, 3 *a*, and 3 *b*.—*Sus giganteus*. Cranium. Upper, palatal, and lateral views. The right zygoma is imperfect, and the left is almost absent; but, in other respects, the cranium is more perfect than in figs. 1 or 2. There are three molars and three premolars on either side. The incisive alveoli and the tuberosity and alveolus of the right canine are also present.—B.M.

Length of fragment, 14·3 in. Width of cranium superiorly at sub-orbital foramen, 1·8 in. Height of ditto from palate, 3·3 in. Length of canine tuberosity, 4· in. Length of molar series, 5·6 in. Length of three true molars, 3·5 in. From posterior border of palate to anterior margin of incisive alveolus, 7·6 in. From posterior border of palate to posterior angle of incisive foramen, 8·7 in. Diasteme between canine and external incisor, 1· in. Width of palate posteriorly, 1·2 in. Ditto between canines, 2· in. Greatest width of alveoli, 1·2 in.

Fig. 4.—*Sus giganteus*. Lower jaw, right side. The ascending ramus is mostly absent. Shows three molars and three premolars, with canine and incisive alveoli.

Length of fragment, 11·5 in. Height of horizontal ramus, 2· in. Thickness of ditto, 1·7 in. Length of symphysis superiorly, 3·3 in. Length of three true molars, 3·5 in. Length of ditto, with three posterior premolars, 5· in. Interval between first and second premolars, ·9 in. Interval between second premolar and canine, 1·5 in. Between canine tuberosities, 3·9 in. Width between molars posteriorly, 1·5 in. Between ditto anteriorly, 1·7 in.

Figs. 5 and 5 *a*.—*Sus scrofa* (var. *Indicus*). Entire skull, with lower jaw, not fossil. Upper and lateral views. One-third of the natural size.—B.M.

PLATE LXX.

Figs. 1 and 1 *a*.—*Sus (Hippohyus) Sivalensis* (Falc. and Caut.).[1] Cranium. Upper and palatal views. Except that the zygomatic arches are absent, the specimen is very perfect. Shows three molars and two last premolars on either side, with alveoli of canines and six incisors. The sub-orbitary and incisive foramina are well marked.—B.M.

Extreme length of fragment, 9·2 in. From post. plane of occipital condyles to anterior margin of incisive alveolus, 9· in. From lower border of occipital foramen to post. border of palate, 2·3 in. From post. border of palate to posterior border of incisive foramen, 5·4 in. Width of palate between second molars, 1·1 in. Width of ditto between inner margins of canine alveoli, 1·05 in. Width of ditto between anterior angles of middle incisive alveoli, ·7 in. Greatest width of alveoli, ·8 in. Length of the molar series, 4·3 in. Length of the three true molars, 2·7 in. Dias-

[1] 'In this extinct genus of quadrupeds from the Himalayan tertiary deposits, the dental formula shows incisors $\frac{3-3}{3-3}$, and corresponds with that of the *Chæropotamus* in the number of canines, premolars and molars; but the true molars have a more complex crown, approaching nearer to those of the typical *Suidæ* in the depth and number of the secondary enamel folds. Each upper true molar has its crown cleft by the common or primary crucial valleys, the transverse one passing somewhat obliquely from within forwards and outwards. Each of the four principal lobes is subdivided, not by a vertical central depression, but by a fold penetrating its anterior and posterior margins. The enamel at first shows additional minor plications, but is worn down to the simpler pattern above described; the outer lobes are convex externally. The first premolar is very small and simple, separated by an interval of its own breadth from the second; both this and the third have transversely compressed crowns; the fourth has a sub-trihedral crown. The *Hippohyus* equalled in size the *Chæropotamus*, but exhibits as strong a tendency towards the Hippopotamoid family as that does towards the plantigrade Carnivora.'—Owen's 'Odontography,' vol. i. p. 562.

tema between first and second premolars, ·2 in. Length of incisor ridge on one side, 1·5 in. Breadth of nasal ridge at sub-orbital foramina, 1·2 in. Between post-orbital processes, 2·5 in.

Figs. 2 and 2 *a*.—*Sus Hysudricus* (Falc. and Caut.). From Sewalik hills. Anterior portion of skull broken off about sub-orbitary foramina. Shows three molars and three premolars and canine *in situ*.—B.M.

Length of fragment, 5·7 in. Height from palate opposite sub-orbital foramen, 2·2 in. Length of three true molars, 1·8 in. Length of ditto and three posterior premolars, 3·3 in. Diastema between first and second premolars, ·1 in. Length of whole molar series, 4· in.

Figs. 3 and 3 *a*.—*Sus Hysudricus*. Lower jaw. The ascending ramus and the incisive and canine alveoli are absent. Shows three molars and four premolars.—B.M.

Extreme length of fragment, 6·4 in. Height of jaw opposite second molar, 2· in. Length of three molars, 3· in. Ditto of entire molar series, 5·3 in.

Figs. 4, 4 *a*, and 4 *b*.—*Sus giganteus*. Superior, palate, and side views of cranium. The specimen is imperfect and mutilated. Posteriorly it is broken off behind the orbit. Anteriorly it is also fractured in front of the first molar, but the anterior fragment is joined on. The specimen shows the two anterior molars and the third molar in germ.—B.M.

Length of fragment, 8· in. Length of palate, 5·5 in. Height from palate at sub-orbital foramen, 1·8 in. Width of cranium superiorly at ditto ditto, 1· in. Length of exposed molar series, 3· in. Of first and second molars, 1·4 in. Between first premolar and external incisor, ·6 in. Between first premolar and internal incisor, 1·4 in. Width of palate posteriorly, ·8 in. Width of palate between canines, 1·3 in.

Fig. 5.—*Sus giganteus*.—Lower jaw, showing three molars and three premolars on either side. The left canine and the alveolus are also seen. The incisive alveoli are imperfect.—B.M.

Extreme length of fragment, 12· in. Length of three true molars, 3·8 in. Of ditto with two premolars, 5· in. Distance between canine and second premolar, 1·9 in. Width of symphysis between external margins of canine alveoli, 3·4 in. Length of symphysis, 5·2 in.

Fig. 6.—*Sus giganteus*. Imperfect specimen of lower jaw. Shows the molars and premolars on right side, and the premolars and canine alveolus on left; also the incisor alveoli.—B.M.

Length of fragment, 7·4 in. Height of ramus, 2·1 in. Width of ramus, 1·4 in. Length of symphysis, 2·8 in. Width between external alveolar margins of canines, 2·8 in. Alveolar margin of four incisors, 1·2 in.

Figs. 7 and 7 *a*.—*Sus giganteus*. Lower jaw, showing three molars, four premolars, canine, and three incisors. The last or posterior molar is intact. The ascending ramus is absent.—B.M.

Length of fragment, 10· in. Depth of ramus at anterior margin of third molar, 2· in. Width of ditto, 1·4 in. Length of symphysis, 2·8 in. Between external alveolar margins of canines, 2·3 in. Length of three posterior premolars and three true molars, 4·9 in. Of three true molars, 3·2 in. Between first and second premolars, ·5 in. Between first premolar and canine, ·3 in. Alveolar margin of three incisors, 1·3 in.

Figs. 8 and 8 *a*.—*Sus giganteus*. Another specimen of lower jaw, with molars, premolars, and canine on both sides; also the incisor alveoli. The third or last molar is only partly ground. The ascending ramus is absent. From the Nerbudda.—B.M.

Length of fragment, 10·1, in. Depth of ramus at anterior margin of last molar,

2·in. Width of ditto, 1·2 in. Length of symphysis, 3·5 in. Between external alveolar margins of canines, 2·7 in. Length of three last premolars and three true molars, 5·5 in. Length of true molar series, 3·1 in. Between first and second premolars, ·6 in. Between first premolar and canine, ·5 in. From anterior margin of canine alveolus to mesial line, 1·5 in. Width between rami posteriorly, 1·5 in.

Plate LXXI.

Fig. 1.—*Sus (Hippohyus) Sivalensis.* Left half of palate, natural size, showing three molars, three posterior premolars, and the alveoli of the first premolar, canine, and three incisors. The third or hindmost molar is not at all ground.—B.M.

Extreme length of palate, 6·3 in. Length of first molar, ·6 in.; of second, ·95 in.; of third, 1·15 in. Width of first molar, ·6 in.; of second, ·8 in.; of third, ·8 in. Length of third premolar, ·5 in.; of fourth, ·5 in. Width of third premolar, ·4 in.; of fourth, ·5 in.; between canine and first premolar, ·6 in.

Fig. 2.—*Sus* (*Hippohyus*) *Sivalensis.* Second and third molars, imperfect.—B.M.

Length of fragment of second molar, ·55 in.; of third, 1·45 in. Greatest width of third posteriorly, ·73 in.

Fig. 3.—*Sus* (*Hippohyus*) *Sivalensis.* First and second true molar and portion of fourth premolar.—B.M.

Length of first true molar, ·5 in.; of second ditto, 1· in. Width of first true molar, ·45 in.; of second, ·63 in.

Fig. 4.—*Sus* (*Hippohyus*) *Sivalensis.* Fourth premolar and first and second true molars.—B.M.

Length of first molar, ·55 in.; of second, ·85 in.

Fig. 5.—*Sus Hysudricus.* Three true molars and third and fourth premolars, upper jaw, left.—B.M.

Length of third premolar, ·5 in.; of fourth ditto, ·5 in.; of first molar, ·6 in.; of second, ·8 in.; of third, 1·1 in. Width of third premolar, ·35 in.; of fourth, ·53 in.; of first molar, ·55 in.; of second, ·66 in.; of third, ·7 in.

Fig. 6.—*Sus Hysudricus.* Three molars and three posterior premolars, lower jaw, left. The last molar is imperfect.—B.M.

Length of second premolar (at alveolar ridge), ·45 in.; of third, ·45 in.; of fourth, ·5 in.; of first molar, ·55 in.; of second, ·7 in. Width of fourth premolar, ·35 in.; of first molar, ·43 in.; of second, ·53 in.

Fig. 7.—*Sus Hysudricus.* Second and third true molars, upper jaw, right.—B.M.

Length of second molar, ·65 in.; of third, ·85 in. Width of second molar, ·7 in. Extreme width of third molar anteriorly, ·7 in.

Fig. 8.—*Sus Hysudricus.* Second and third true molars, well worn.—B.M.

Length of second molar, ·73 in.; of third, 1·4 in. Width of second, ·6 in.; of third anteriorly, ·65 in.

Fig. 9.—*Sus Hysudricus.* Canine, four premolars, and first and second molar, upper jaw, right.—B.M.

Length of first premolar, or retained milk molar, ·4 in.; of second, ·5 in.; of third, ·5 in.; of fourth, ·45 in.; of first molar, ·6 in.; of second, ·65 in.

Fig. 10.—*Sus Hysudricus.* Three molars, and two posterior premolars, lower jaw.—B.M.

Length of last premolar, ·5 in.; of first molar, ·5 in.; of second, ·66 in.; of third, 1· in. Width of last premolar, ·35 in.; of first molar, ·4 in.; of second, ·5 in.; of third ditto anteriorly, ·5 in.

Fig. 11.—*Sus Hysudricus.* Symphysis of lower jaw, with four premolars on left side, and second and third on right.—B.M.

Distance between inner margins of second premolars, 1·3 in. Length of second premolar, ·45 in.; of third, ·5 in.; of fourth, ·5 in.

Fig. 12.—*Sus giganteus.* Three true molars, upper jaw, left. The first is imperfect.—B.M.

Length of first molar, ·65 in.; of second, 1· in.; of third, 1·6 in. Width of first molar, ·75 in; of second, ·9 in.; of third anteriorly, 1· in.

Fig. 13.—*Sus giganteus.* Second and third true molars, upper jaw, right; large and perfect.—B.M.

Length of second molar, 1·4 in.; of third, 2·2 in. Width of second molar, ·8 in.; of third ditto, 1·1 in.

Fig. 14.—*Sus giganteus.* Lower jaw, right side, showing canine, four molars, and first two true molars. The second true molar is not at all ground down, and the third has not appeared.

Distance between canine and first premolar, ·36 in. Length of first premolar, ·36 in.; of second, ·5 in.; of third, ·5 in.; of fourth, ·5 in.; of first molar, ·85 in.; of second, 1·25 in. Width of first molar, ·7 in.; of second, ·8 in.

Fig. 15.—*Sus giganteus.* Lower jaw, right side, with first, second, and third true molars, all well ground.—B.M.

Length of first molar, ·55 in.; of second, ·95 in.; of third, 1·8 in. Width of first molar, ·55 in.; of second, ·7 in.; of third, ·7 in.

Fig. 16.—*Sus giganteus.* Last premolar and first molar, upper jaw.—B.M.

Length of last premolar, ·7 in.; of first molar, ·93 in. Width of last premolar, ·8 in.; of first molar posteriorly, ·9 in.

Figs. 17 and 17 *a.*—*Sus giganteus.* Anterior portion of lower jaw, showing canine and incisive alveoli. The outer incisor on both sides has dropped out; the two inner incisors and the canines are present; the latter are broken off.—B.M.

Distance between outer margins of outer incisive alveoli, 2·1 in.; between outer margins of middle ditto, 1·6 in.; antero-posterior diameter of middle incisor, ·36 in.; of inner ditto, ·4 in.

Figs. 18 and 18 *a.*—*Sus giganteus.* Symphysis of lower jaw, with six incisors very perfect. The canines are broken off.—B.M.

Length of symphysis measured inferiorly, 2·6 in. Distance between outer margins of outer incisors, 2· in.; between outer margins of second premolars, 1·8 in. Width of three incisors on one side, 1·2 in.

Figs. 19, 19 *a*, and 19 *b.*—*Sus giganteus.* Fragment of canine, slightly compressed and grooved on each side.—B.M.

Length of fragment, 2·4 in.; great diameter, 1·15 in.; lesser diameter, ·8 in.[1]

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[1] *Description by Dr. Falconer of Fossil Remains of Suidæ from the Sewalik Hills, in the Museum of the Asiatic Society of Bengal.*

No. 317. *Sus*——? Conglomerated specimen, consisting of a mass of bones cemented together by clay-marl and crossing each other in every direction: the principal object being the lower jaw, nearly entire, of a *Sus*, exposed so as to

Plate LXXII.

Figs. 1, 1 *a*, and 1 *b*.—*Rhinoceros platyrhinus*. (Falc. and Caut.) From the Sewalik hills. Mutilated cranium, anterior part, showing lateral, upper, and palate surfaces. The specimen is so worn that the teeth are scarcely distinguishable. The upper surface of the skull is broad and flat.—B.M. (See *antea*, p. 157, and Pl. XIV. fig. 3.)

Length of fragment, 17·in.; height posteriorly, 9·7 in.; height anteriorly, 8·in.; greatest breadth at anterior angles of orbits, 10·6 in.; depth of nasal notch, 6·in.; height of nasal notch anteriorly, 5·5 in.

In 1847 Dr. Falconer noted that *R. platyrhinus* partakes of the characters of both *R. leptorhinus* (*sic*) and *R. tichorinus*, and on the 9th of August, 1860, he made the following note:—

'Examined Baker's large skull of the Sewalik *Rhinoceros platyrhinus* in B.M. The molars are in fine condition, six on either side. The last true molar only just touched by wear. The last t. m. exactly like *Rh. hemitœchus*, in having a posterior basal funnel-shaped pit! while the penultimate and antepenultimate t. m. and the penultimate and antepenultimate milk m. have each three distinct fossettes, as in *Rhinoceros tichorhinus*! the vertical ridges of the anterior side very well pronounced in three valleys. Had two large incisors above and four below: of the latter, the two outer big; the two inner small, as in the existing Indian Rhinoceros.'

Figs. 2, 2 *a*, and 2 *b*.—*Rhinoceros platyrhinus*. Fragment showing posterior part of cranium, with foramen magnum, occipital condyles and crest, portion of right zygomatic arch, and condyle of lower jaw. —B.M.

Length of fragment, 10·6 in.; height of occipital facet from lower margin of occipital foramen to summit of occipital crest, 12·in. Breadth of occipital facet above, 8·4 in.; ditto below, 13·2 in. Height of occipital foramen, 2·5 in.; breadth of ditto, 2·in. Between extreme points of occip. condyles, 5·3 in. Least width of cranium, 3·3 in. Breadth of condyle of lower jaw, 6·7 in.; ditto of ascending ramus, 6·in. Between inner angles of glenoid facets, 2·5 in. Depth of zygomatic process, 3·3 in.

Fig. 3.—*Rhinoceros platyrhinus*. Fragment of skull, upper jaw, with molar ridge, and large sub-orbital foramen.—B.M.

Length of fragment, 13·2 in. From root of molar origin of zygoma to sub-orbital foramen, 7·5 in. Length of molar series, 10·8 in. Greatest breadth of molar alveoli, 2·8 in.

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show the two horizontal rami with the remains more or less of seven molars on either side, the bases of both canines and more or less of the six incisors. The specimen is still much covered with matrix; the four premolars on the left side show part of their crowns; on the right side the first premolar is close to the canine; the true molars are well worn; the canine on the left side shows a part of the tooth bending outwards, but the apex broken off. The other bones are so much covered by matrix as to be undeterminable.

No. 318. *Sus* —— ? Fragment comprising the posterior part of upper maxilla right side, containing the two last teeth *in situ*; the penultimate is well worn, showing a very complex pattern of crown; the last molar is half worn.

No. 319. *Sus* —— ? Fragment of lower jaw, right side, comprising posterior part of horizontal ramus, broken across horizontally near the base of the teeth, and containing the last two molars, the penultimate well worn with very flexuous enamel; the last molar in germ and of very large size.

No. 320. Mutilated fragment comprising part of the last true molar, much broken and cemented with matrix.

No. 321. Fragment comprising the posterior part of horizontal ramus lower jaw right side, containing the two last teeth *in situ*; they are in the same condition of wear as No. 319, but considerably smaller.

No. 54 (from Perim Island). Lower jaw, left side, fragment containing merely the last molar of *Sus Hysudricus*?

Fig. 4, 4 *a*, 4 *b*, and 4 *c*.—*Rhinoceros platyrhinus*. Fragment showing anterior portion of lower jaw, with symphysis and four anterior molars, and a portion of fifth; also a small inner and large outer incisor on both sides.—B.M. (See *antea*, p. 157.)

Length of fragment, 13·5 in. Breadth of symphysis, 5·7 in. Length of symphysis inferiorly, 7· in. Depth of jaw, 4·7 in. Thickness of jaw, 3·3 in. Length of four anterior molars, 7·4 in. Between anterior premolar and external incisive alveolus, 3·1 in. Between incisive alveoli, ·6 in. Width between molars posteriorly, 4· in.; ditto anteriorly, 3·4 in.

Figs. 5, 5 *a*, and 5 *b*.—*Rhinoceros platyrhinus*. Small fragment of lower jaw, with two molars.—B.M.

Length of fragment, 6·7 in.; greatest depth, 5·7 in.; Thickness, 3·2; length of molar, 3·1 in.; breadth, 1·7 in.

Figs. 6 and 6 *a*.—*Rhinoceros platyrhinus*. Fragment of molar.—B.M.

Length, 2·3 in. Width, 3·4 in.

Figs. 7 and 7 *a*.—*Rhinoceros platyrhinus*. Molar.

Length, 3·2 in.; breadth, 2·8 in.; height of crown, 3·1 in.

Plate LXXIII.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Rhinoceros Palæindicus*. (Falc. and Caut.) Mutilated specimen of cranium. The zygomatic arches and the anterior portion of the palate are broken off. On the right side the three true molars and three posterior premolars are present; on the left there are three molars and one premolar. All the teeth are much worn. The upper surface of the skull is very concave.—B.M. (See *antea*, p. 157.)

Length of fragment, 21·8 in. Height of occiput (imperfect) from basilar process, 8·1 in. From occipital surface to posterior border of palate (imperfect), 12·5 in. Between mastoid angles, greatest diameter of occiput, 9· in. Transverse diameter of occipital foramen, 1·9 in. Vertical ditto, 1·3 in. Breadth of cranium at anterior orbital angles, 8·7 in. Between anterior angles of orbital margin, 3·9 in. Between sub-orbital foramina (posterior border), 4·8 in. Chord of nasal notch, 4·5 in. Length of three true molars, 6·1 in. Length of three posterior premolars, 5· in. Width of palate between posterior molars, 2·2 in. Ditto between second premolars, 2·5 in. Greatest width of alveolus, 2·8 in. Length of palatine notch, 5·5 in. Width of ditto, 2· in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—*Rhinoceros Sivalensis* (Falc. and Caut.), from the Sewalik hills. Tolerably perfect specimen of cranium. The upper part of the occiput and the left zygoma are absent. The left maxilla shows three molars and three premolars, and also the alveolus of the first premolar. The teeth are well worn; the palate is narrow. The upper surface of the cranium is concave, and the tip of the nasal shows the gibbosity of the base of a very large horn. The species was evidently unicorned.—B.M. (See *antea*, p. 157, and Pl. XIV. fig. 1.)

Extreme length of fragment, 22·5 in. From posterior plate of occipital condyles to anterior margin of first premolar, 20·4 in. From lower border of occipital foramen to posterior border of palate, 11·9 in. Length of molar series, 11·1 in. Length of three true molars, 5·8 in. Width of palate between posterior molars, 2·5 in. Width of palate at anterior angle of first premolars, 2·2 in. Greatest width of alveoli, 2·6 in. Length of palatine notch, 5·3 in. Width of ditto, 1·9 in. Between inner angles of articular surfaces for lower jaw, 3·2 in. Between most distant points of zygomatic processes, 13·7 in. Depth of zygomatic fossa, 3·1 in. Height of occiput (imperfect) from lower border of occipital foramen, 9· in. Between outer angles of occipital condyles, 4·8 in. Between mastoid angles, or greatest transverse diameter of occiput, 8·6 in. Breadth of occipital foramen, 1·7 in. Height of ditto,

1·9 in. Breadth of cranium at anterior orbital angle, 8·3 in. Between posterior borders of sub-orbital foramina, 5·2 in. Between anterior angle of orbital margin and posterior border of sub-orbital foramen, 4·7 in. Breadth of rostrum, 2·8 in.

Figs. 3 and 3 *a*.—*Rhinoceros Sivalensis*. Fragment of skull, comprising upper jaw, portion of orbit and prolongation of nasals for horn.—B.M.

Length of fragment, 14·8 in. From anterior angle of orbit to tip of nasal protuberance, 9·8 in. From concavity of nasal notch to tip of ditto, 6·8 in.

Plate LXXIV.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Rhinoceros Palæindicus*. Very perfect specimen of cranium, with both zygomatic arches entire. Shows two molars and two posterior premolars on either side. The third molar is still in germ. The palate is deficient in front.—B.M.

Length of cranium (fragment), 18·2 in. Between most projecting points of zygomata, 9·8 in. Breadth of occiput (behind the auditory foramina), 6·1 in. Least breadth of cranium (between the temporal fossæ), 3·4 in. Breadth of cranium at anterior orbital angles, 5·3 in. From anterior margin of second premolar to posterior border of pterygoid process, 9·7 in. Length of palatine fissure, 3·7 in. Distance between the internal angles of the glenoid facets, 3· in. Length of alveolar margin of exposed molars, 6·1 in. Between external alveolar margins of last exposed molars, 6·4 in. Between external alveolar margins of anterior molars, 3·7 in. Height of cranium from alveolar margin at anterior margin of third molar, 6·1 in. Width of palate anteriorly, 2·3 in.; ditto, posteriorly, 2·3 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—*Rhinoceros Palæindicus*. Skull of a larger and older animal than fig. 1. Both zygomatic arches are deficient, and the portion in front of the fourth premolar is also broken off.—B.M.

Length of fragment, 20·1 in. From lower margin of occipital foramen to posterior border of palate, 12·2 in. From ear (anterior margin) to sub-orbital foramen, 13·5 in. From ditto to anterior angle of orbit, 10·6 in. Height of occipital facet from lower margin of occipital foramen to occipital crest, 7·7 in. Height of cranium at anterior angle of orbit from alveolar border, 7·2 in. Height of occipital foramen, 1·2 in. Breadth of ditto, 1·2 in. Between internal angles of glenoid facets, 3·3 in. Width of palate posteriorly and anteriorly, 3·1 in. Between extreme points of external alveolar borders of molars, 10· in. Least breadth of cranium (between temporal fossæ), 4·3 in. Breadth of cranium at anterior orbital angles, 8·5 in. From centre of occipital crest to posterior border of nasal notch, 16·7 in. Length of alveolar border of three true molars, 6·5 in. Breadth of alveoli, 3·2 in.

Figs. 3 and 3 *a*.—*Rhinoceros Palæindicus*. Fragment of lower jaw, left side, with four posterior molars.—B.M.

Length of fragment, 15·8 in. Length of alveolar border of molars, 8·3 in. Breadth of ascending ramus, 6· in. Depth of jaw anteriorly, 3·1 in. Thickness of ditto, 3·2 in.

Figs. 4 and 4 *a*.—*Rhinoceros Palæindicus*. Fragment of symphysis of lower jaw, with incisive alveolar ridge and large outer left incisor.—B.M. (See *antea*, p. 157.)

Between external alveolar borders of incisive alveoli, 4·5 in. Length of existing portion of symphysis, 4·4 in. Interval between anterior premolar and incisive alveolus, 2·6 in. Greatest thickness of alveolus, 1·7 in. Great diameter of incisor, 1·3 in. Lesser diameter of ditto, 1·1 in. Length of tusk (projection), 1·9 in.

Fig. 5.—*Rhinoceros Sivalensis*. Portion of cranium, showing palate with molar ridges and nasal projections. The portion behind the second molar is broken off.—B.M.

Length of fragment, 14·8 in. Width of palate between second molars, 2·3 in. Width of palate between first premolars, 1·6 in. Length of four premolars and first and second molar series, 8· in. Length of four premolar series, 4·9 in. Supposed depth of nasal notch, 6·6 in. Breadth of cranium between anterior angles of orbit, 7·7 in. Between external alveolar borders posteriorly, 7·3 in. Between ditto anteriorly, 2·5 in.

Figs. 6 and 6 *a*.—*Rhinoceros Sivalensis.* Fragment of lower jaw, with symphysis and five anterior molars.—B.M.

Length of fragment, 9·4 in. Length of existing portion of symphysis, 3·1 in. Length of molar series, 7· in. Width between the posterior molars, 2·7 in. Between anterior ditto, 2· in. Greatest depth of jaw, 3·6 in. Thickness of ditto, 2· in.

PLATE LXXV.

Fig. 1.—*Rhinoceros Palæindicus.* Fragment of upper jaw, left side, with three true molars.

Length of first molar, 2· in.; of second, 2·15 in.; of third along anterior edge, 3·1 in. Width of first molar, 3· in.; of second, 3·2 in.; of third along anterior edge, 2·9 in.

Fig. 2.—*Rhinoceros Palæindicus.* Fragment of lower jaw, with three true molars and fourth premolar.—B.M.

Length of fourth premolar, 1·8 in.; of first molar, 2·15 in.; of second, 2·2 in.; of third, 2·2 in. Width of fourth premolar, 1·35 in.; of first molar, 1·3 in.; of second, 1·4 in.; of third, 1·3 in.

Fig. 3.—*Rhinoceros Palæindicus.*—Fragment of lower jaw, with four molars.—B.M.

Length of first tooth, ·65 in.; of second, 1·3 in.; of third, 1·75 in.; of fourth, 1·75 in.

Fig. 4.—*Rhinoceros Palæindicus.* Premolar tooth detached.—No. 39,648 B.M.

Length along outer edge, 2·5 in. Width of grinding surface anteriorly, 2·5 in.

Fig. 5.—*Rhinoceros Sivalensis.* Fragment of upper jaw, right side, with three true molars and third and fourth premolar.—B.M. (Reproduced in Pl. XIV. fig. 2.)

Length of third premolar, 1·6 in.; of fourth ditto, 1·5 in.; of first molar, 1·75 in.; of second ditto, 2· in.; of third ditto along outer edge, 2·3 in. Width of third premolar, 2·3 in.; of fourth ditto, 2·6 in.; of first molar, 2·6 in.; of second ditto, 2·6 in.; of third ditto along anterior edge, 2·5 in.

Fig. 6.—*Rhinoceros Sivalensis.* Lower jaw, right side, with second, third, and fourth premolars, and first and second true molars.—B.M.

Length of second premolar along outer edge, 1·2 in.; of third premolar at centre of grinding surface, 1·2 in.; of fourth ditto, 1·7 in.; of first molar, 1·6 in.; of second ditto, 1·9 in. Width of second premolar, ·75 in.; of third ditto, 1·0 in.; of fourth ditto, 1·15 in.; of first molar, 1·3 in.; of second ditto, 1·36 in. Width between anterior angles of second premolars, 2·4 in.

Fig. 7.—*Rhinoceros Sondaicus* (recent). Upper jaw, right side, with fourth premolar and three true molars.

Length of fourth premolar, 1·55 in.; of first molar, 1·6 in.; of second, 1·9 in.; of third along outer edge, 2·1 in.

Fig. 8.—*Rhinoceros Sondaicus* (recent). Lower jaw, right side, with third and fourth premolars and three true molars.

Length of third premolar, 1·2 in.; of fourth, 1·5 in.; of first molar, 1·6 in.; of second, 1·8 in.; of third, 1·7 in.

Fig. 9.—*Rhinoceros platyrhinus.* Upper jaw, right side, with third and fourth premolars and three true molars. The first true molar is imperfect.—B.M.

Length of third premolar, 1·6 in.; of fourth ditto, 1·8 in.; of fragment of first molar, extreme, 1·5 in.; of second molar, 1·9 in.; of third ditto along outer edge, 2·2 in. Width of third premolar, 2·7 in.; of fourth ditto, 2·8 in.; of second molar, 2·9 in.; of third ditto along anterior edge, 2·55 in.

Fig. 10.—*Rhinoceros platyrhinus.* Lower jaw, right side, and symphysis, containing very large outer and small inner incisor of both sides, second, third, and fourth premolars, and first two true molars of right side.—B.M. (Reproduced in Plate XIV. fig. 4.)

Length of second premolar, ·7 in.; of third ditto, 1·4 in.; of fourth ditto, 1·65 in.; of first molar, 1·46 in.; of second ditto, 2· in. Width of second premolar, ·45 in.; of third ditto, ·85 in.; of fourth ditto, 1·1 in.; of first molar, 1·05 in.; of second ditto, 1·2 in. Width between second premolars, 3·5 in.; ditto between outer margins of external incisors, 3·65 in. Oblique width of external incisor, 1·5 in. Thickness externally of ditto, oblique, ·7 in. Length of exserted portion along outer edge, 2·1 in.

Fig. 11.—*Rhinoceros platyrhinus.* Penultimate true molar upper jaw, right side, detached, but shattered. Fig. 11 *a*.—Ditto, ditto, restored.—B.M.

Fig. 12.—Last true molar upper jaw, right side.—B.M.

Fig. 13.—*Rhinoceros* (*Acerotherium?*) *Perimensis* (from Perim Island). Fragment of lower jaw, with three true molars and first premolar.

Length of first true molar, 1·15 in.; of second, 1·4 in.; of third, 1·5 in.

Fig. 14.—*Rhinoceros Perimensis.* Premolar tooth, detached.

Fig. 15.—*Rhinoceros Perimensis.* Molar, detached and shattered.

Fig. 16.—*Rhinoceros Perimensis.* Molar, detached and shattered.

PLATE LXXVI.

Divers Indian Fossil Species of Rhinoceros.

Figs. 1 and 1 *a*.—Fragment of left humerus, near upper end, from the Niti Pass.—B.M. (See *antea*, p. 173, and Plate XV.)

Length of fragment, 5·9 in. Breadth, 3·5 in. Greatest thickness of fractured surface, 2·3 in.

Fig. 2.—Fragment of left humerus, near upper end, from the Niti Pass.

Length of fragment, 5·2 in.; greatest breadth, 5·2 in.; thickness, 2·3 in.

Fig. 3.—Upper extremity and portion of shaft of left radius, from the Niti Pass.—B.M.

Length of fragment, 6· in.; greatest antero-posterior diameter of superior articular surface, 2·5 in. Transverse diameter of perfect portion, 2·1 in. Transverse diameter of shaft at fractured portion, 2·1 in. Antero-posterior diameter of ditto, 1·5 in.

Fig. 4.—Upper extremity and portion of shaft of tibia, from the Niti Pass.—B.M.

Length from anterior margin of the crista tibiæ to posterior border of articular surface, 4·8 in. Breadth of inner condyloid fossa, 2·6 in. Antero-posterior diam. of inner condyloid fossa, centre, 2·3 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Scaphoid bone of carpus, left side, from the Niti Pass.—B.M.

Greatest antero-posterior diameter, 2·2 in. Greatest transverse ditto, 3·3 in. Greatest vertical, 2·6 in.

Figs. 6, 6 *a*, and 6 *b*.—Fragment of scapula, including glenoid cavity and coracoid process, from the Niti Pass.—B.M.

Length of fragment, 5·8 in. Height of glenoid cavity, 2·9 in. Greatest breadth of ditto, 2·4 in. Height of coracoid process above glenoid cavity, 1·6 in.

Figs. 7, ·7 *a*, 7 *b*, and 7 *c*.—First phalanx, from the Niti Pass.—No. 39,654 B.M.

Length (superiorly), 1·3 in. Transverse diameter of posterior surface, 2· in. Vertical ditto, 1· in. Transverse diameter of anterior surface, 1·7 in.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—Second phalanx, from the Niti Pass.—B.M.

Length between centres of articular surfaces, 1·1 in. Greatest breadth, 2·5 in. Breadth of posterior articular surface, 1·8 in. Breadth of anterior articular ditto, 1·6 in. Height of posterior articular surface, ·8 in.

Fig. 9.—Fragment of bone of Rhinoceros, from the Niti Pass.

Length of fragment, 1·7 in. Breadth, 1·2 in.

Figs. 10, 10 *a*, and 10 *b*.—Fragment of lower end of femur, from the Niti Pass.—B.M.

Antero-posterior diameter internally, 6·6 in. Length of rotular surface ditto, 4·3 in. Length of rotular surface in centre, 2·8 in. Breadth of ditto in centre of height, 2·8 in.

Figs. 11, 11 *a*, and 11 *b*.—Fragment of head of humerus from Beloochistan (See p. 395).

Length of fragment, 6·4 in. Breadth of upper extremity, 3·5 in. Smallest antero-posterior diameter of ditto, 2·6 in. Greatest diameter of head (articular surface), 2·7 in. Length of crest of great tuberosity, 5·9 in.

Figs. 12, 12 *a*, and 12 *b*.—Fragment of lower end of right radius, from Beloochistan.

Breadth of inferior articular surface, 3·3 in. Length of ridge dividing scaphoid and semilunar surfaces, 1·4 in. Breadth of scaphoid surface, 1·8 in. Breadth of semilunar ditto, 1·5 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Scaphoid of right carpus, from Beloochistan.

Antero-posterior diameter, 2·9 in.; transverse, 3·4 in.; vertical, 2·8 in.

Figs. 14 and 14 *a*.—Fragment of adult lower jaw of *Rhinoceros Perimensis*, horizontal ramus, containing three true molars.—Col. Fulljames.

Length of fragment, 15·9 in. Depth of ramus, 4·5 in. Thickness, 3· in. Length of three true molars, 7·9 in.

Figs. 15 and 15 *a*.—Fragment of horizontal ramus of lower jaw of *Rhinoceros Perimensis*, containing three true molars, which agree closely with those of Kaup's *Acerotherium incisivum*.—B.M.

Length of fragment, 12·5 in. Depth of ramus, 5·2 in. Thickness, 2·1 in. Length of three true molars, 7· in.

Figs. 16, 16 *a*, and 16 *b*.—Upper articulating extremity of femur of *Rhinoceros Perimensis*.—B.M.

Length of fragment, 8·4 in. Breadth of upper extremity, including great trochanter, 9·1 in. Diameter of articular surface of head, 4· in.

Figs. 17, 17 *a*, and 17 *b*.—Metacarpal bone (medius) of *Rhinoceros Perimensis*.

Extreme length, 7·7 in. Smallest transverse diameter of shaft, 2·2 in. Breadth of posterior articular surface, 1·9 in. Height of ditto, 1·9 in.

Figs. 18, 18 *a*, and 18 *b*.—Astragalus of Rhinoceros from the Nerbudda Pass.—B.M.

Breadth of tibial surface, 3· in. Smallest antero-posterior diameter, 1·7 in. Breadth of scaphoid surface, 1·9 in. Greatest breadth of cuboid surface, ·9 in. Height of scaphoid surface, 1·8 in. Height of cuboid surface, 2· in.

Figs. 19, 19 *a*, 19 *b*, and 19 *c*.—Scaphoid bone of carpus of Rhinoceros.

Figs. 20, 20 *a*, and 20 *b*.—Head of humerus.

Figs. 21, 21 *a*, and 21 *b*.—Lower extremity of right radius.

Plate LXXVII.

Bones of Anterior Extremity of divers Fossil Indian Species of Rhinoceros.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Humerus, radius, and ulna *in situ*. This specimen was described and figured by Messrs. Baker and Durand in the Journ. As. Soc. for August 1836, vol. v. p. 498, Plate XVII. figs. 1 and 2. The humerus is perfect, with the exception of the deltoid crest. The length of the humerus exceeds that of any of the existing species of Rhinoceros. Its thickness, in proportion to the length of the bone and the development of the articulating pulley, are intermediate between the Sumatra and Indian species. The breadth at the condyles is nearly in the same proportion as that of the Indian Rhinoceros. The length of the radius in proportion to the femur is a little less than in the Indian, and somewhat in excess of the small Sumatra species.—B.M. (See *antea*, p. 163.)

Length of humerus from upper articular surface to lower surface of inner condyle, 17·3 in. Extreme length of humerus, 21· in. Greatest width of humerus at termination of deltoid crest, 6·3 in. Greatest width of humerus at upper extremity, 6·2 in. Greatest oblique diam. of humerus at lower extremity, 7·8 in. Greatest ant. posterior diam. of upper extremity, 6·3 in. Greatest ant. post. diam. of lower extremity, 5· in. Circumference of shaft beneath deltoid crest, 11·5 in. Diameter of upper articular surface, 4·2 in. Width of lower articular surface, 4·6 in. Length of radius, 15·5 in. Width of upper extremity of ditto, 4·8 in. Probable width of lower extremity of ditto, 4·8 in. Length of ulna (olecranon broken), 19·3 in. Width of conjoined lower surfaces of radius and ulna, 6·6 in. Circumference round centre of conjoined shafts, 11·7 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—Humerus, with strongly-developed deltoid crest. This specimen also is described and figured by Messrs. Baker and Durand, Journ. As. Soc., vol. v. p. 499, Plate XVII. fig. 5.—B.M.

Length of fragment, 12·2 in. Width including deltoid crest (upper extremity), 8· in. Antero-posterior diameter of ditto, 6·1 in. Length of deltoid crest, 8·2 in. Greatest width of lower extremity, 7· in. Antero-posterior diameter of ditto internally, 4·6 in. Width of lower articular surface, 4·4 in.

Figs. 3, 3 *a*, and 3 *b*.—Fragment of head of humerus.—B.M.

Length of fragment, 12·5 in. Width of upper extremity, including deltoid crest, 7·9 in. Antero-posterior diameter of ditto, 5· in. Length of deltoid crest, 8·6 in. Diameter of articular surface of head, 3·6 in.

Figs. 4, 4 *a*, and 4 *b*.—Fragment of lower end of humerus, with articulating surface.

Length of fragment, 10·4 in. Width of lower extremity, 5·4 in. Antero-posterior of lower extremity internally, 4·7 in.

Figs. 5, 5 *a*, and 5 *b*.—Fragment of lower end of humerus, with articulating surface.—B.M.

Length of fragment, 9·2 in. Width of lower extremity, 5·3 in. Antero-posterior diam. of lower extremity internally, 4·3 in.

Fig. 6.—Upper articulating surface of ulna, with upper end of radius. The tip of the olecranon is broken off.—B.M.

Width of articulating surface, 4·3 in. Chord of sigmoid cavity, 2·4 in.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Upper end of ulna, with entire radius.—B.M.

Extreme length of conjoined radius and ulna, 15·3 in. Length of radius from upper surface to styloid process, 11·3 in. Width of upper extremity of radius, 4· in. Width of lower extremity of radius across epiphysial line, 4· in. Circumference of radius in centre of shaft, 5·5 in.

Figs. 8, 8 *a*, and 8 *b*.—Fragment of radius, with lower articulating surface.—B.M.

Length of fragment, 9·4 in. Circumference of shaft at fractured extremity, 6·7 in. Width of lower articular surface, 3·6 in.

Figs. 9, 9 *a*, 9 *b*, and 9 *c*.—Fragment of ulna, with lower articulating surface.—B.M.

Length of fragment, 12·2 in. Greatest width of lower articular surface, 2· in. Least transverse diameter of shaft of tibia, 2·7 in.

Plate LXXVIII.

Bones of Posterior Extremity of divers Fossil Indian Species of Rhinoceros.

Figs. 1, 1 *a*, and 1 *b*.—Femur of fossil Rhinoceros from the Sewalik hills. The figures are copied from drawings by Messrs. Baker and Durand, in the Journ. Asiatic Soc. for Aug. 1836, vol. v. p. 499. The specimen was found in close proximity to the humerus and radius, Plate LXXVII., fig. 1, so that there could be no doubt that it belonged to the same animal. It is perfect except at the lower part of the great trochanter. The fossil has a greater development in its anterior, and a somewhat less development of its posterior, extremity, than in the Indian Rhinoceros, but the difference is not excessive. The third trochanter also differs from the existing species, as figured in Cuvier's 'Oss. Foss.,' in not possessing the double point, for it has a single well-defined ascending process, without any sign of the bicuspid termination (See *antea*, p. 164).

Length from head to bottom of inner condyle, 24·5 in.; from head to bottom of third trochanter, 17·7 in. Breadth from head to most salient point of great trochanter, 10·6 in. Breadth across condyles, 6·82 in. Diameter of articulating head, 4·65 in. Antero-posterior diameter of inner condyle, 8·45 in.; antero-posterior diameter of outer, 6·35 in.

Figs. 2 and 2 *a*.—Mutilated fragment of upper end of femur.—B.M.

Extreme length of fragment, 11·5 in. Width across third trochanter, 6· in. Circumference below third trochanter, 9·5 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Tibia and fibula conjoined.—B.M.

Extreme length of tibia, 16·9 in. Extreme length of fibula, 16· in. Extreme transverse diameter of upper extremity of tibia, 6·1 in. Extreme antero-posterior diameter of upper, including tuberosity, 7· in. Extreme width of lower articular surface, 3·8 in. Extreme antero-posterior diameter of ditto, 3·1 in. Least circumference of shaft of tibia, 9·1 in.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—Fragment of tibia almost perfect.—B.M.

Extreme length, 13·6 in. Least circumference of shaft, 8· in.

Figs. 5, 5 *a*, and 5 *b*.—Fragment of tibia, including lower articulating surface.—B.M.

Length of fragment of tibia, 11·8 in. Width of inferior articular surface, 3·4 in. Least circumference of shaft, 8·1 in.

Figs. 6 and 6 *a*.—Patella.—B.M.

Height, 4·1 in.

Figs. 7 and 7 *a*.—Patella.

Height, 4·7 in. Width of articulating surface, 4· in. Height of ditto, 2·9 in.

Figs. 8, 8 *a*, and 8 *b*.—Bones of tarsus (calcaneum, scaphoid, cuboid, and three cuneiforms) with index and medius metatarsals. The calcaneum and scaphoid do not belong to the remainder.—B.M.

Greatest width of scaphoid, 3·1 in. Greatest width of cuboid, 2· in. Greatest width of external cuneiform, 2·3 in. Greatest width of middle ditto, 1·3 in. Greatest width of inner ditto, 1·9 in. Greatest width of upper articular surface of medius, 2·35 in. Greatest width of upper extremity of index, 1·75 in.

Figs. 9, 9 *a*, and 9 *b*.—Calcaneum.—B.M.

Extreme length, 5·5 in. Height, 3·4 in. Width, 2·8 in.

Figs. 10, 10 *a*, and 10 *b*.—Calcaneum.

Extreme length, 6·5 in. Height, 2·9 in. Width, 3·9 in.

Figs. 11 and 11 *a*.—Calcaneum.—B.M.

Extreme length, 5·8 in. Height, 3·1 in. Width, 3·4 in.

Figs. 12, 12 *a*, and 12 *b*.—Astragalus.—B.M.

Width of anterior articular surface, 3· in. Greatest width of cuboid segment of ditto, 1· in. Width of trochlea, 3·6 in. Antero-posterior diam. of trochlea in centre, 2· in. Greatest height, 2·8 in. Greatest antero-posterior diameter internally, 3·6 in.

Figs. 13, 13 *a*, and 13 *b*.—Astragalus.

Width of anterior articular surface, 3·4 in. Greatest width of cuboid segment of ditto, 1·1 in. Width of trochlea, 3·3 in. Antero-posterior diam. of trochlea in centre, 2· in. Greatest height, 2·6 in. Greatest antero-posterior diameter internally, 3·5 in.

Plate LXXIX.

Bones of Anterior and Posterior Extremities of divers Fossil Indian Species of Rhinoceros.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Left scaphoid bone of carpus.—B.M.

Height, 2·5 in. Width of inferior articular surface, 2·9 in. Greatest antero-posterior diameter, 2·6 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—Left scaphoid of carpus.—B.M.

Greatest height, 2·6 in. Antero-posterior diameter, 2·35 in. Width of inferior articular surface, 2·7 in.

Figs. 3, 3 *a*, and 3 *b*.—Unciform bone of carpus.—B.M.

Greatest antero-posterior diameter of upper surface, 2·1 in.

Figs. 4, 4 *a*, and 4 *b*.—Unciform bone of carpus.—B.M.
Greatest antero-posterior diameter of upper surface, 2·2 in.

Figs. 5, 5 *a*, and 5 *b*.—Unciform bone of carpus.—B.M.
Greatest antero-posterior diameter of upper surface, 1·6 in.

Figs. 6, 6 *a*, and 6 *b*.—Trapezoid bone of carpus.
Antero-posterior diameter of upper articular surface, 1·4 in.

Figs. 7, 7 *a*, and 7 *b*.—Left index metacarpal bone.—B.M.
Extreme length, 6·5 in. Width of shaft in centre, 1·7 in.

Figs. 8, 8 *a*, and 8 *b*.—Right index metacarpal bone.—B.M.
Extreme length, 6·5 in. Width of shaft in centre, 1·5 in.

Figs. 9, 9 *a*, and 9 *b*.—Left index metacarpal bone.—B.M.
Extreme length, 6·6 in. Width of trapezoid surface, 1·1 in. Width of shaft in centre, 1·6 in.

Figs. 10, 10 *a*, and 10 *b*.—Left medius metacarpal bone.—B.M.
Extreme length, 7·2 in. Greatest width of shaft, 2·3 in.

Figs. 11, 11 *a*, and 11 *b*.—Left medius metacarpal bone.—B.M.
Extreme length, 7·3 in. Extreme width of shaft, 2·3 in.

Figs. 12, 12 *a*, and 12 *b*.—Left medius metacarpal bone.—No. 39,655 B.M.
Width of surface for os magnum, 2· in. Width of surface for os unciforme, 1· in. Width of shaft, 2· in.

Figs. 13, 13 *a*, and 13 *b*.—Left annularis metacarpal bone.—B.M.
Extreme length, 6·5 in. Width of shaft in centre, 1·7 in.

Figs. 14, 14 *a*, and 14 *b*.—Left annularis metacarpal bone.—B.M.
Extreme length, 6·3 in. Width of facet for unciform, 1·5 in. Width of shaft in centre, 1·5 in. Width of distal articular surface, 1·65 in.

Figs. 15 and 15 *a*.—Index and medius metatarsal bones conjoined. *b*. Index. *c*. Medius.—B.M.
Extreme length of index, 6·5 in. Extreme length of medius, 7·5 in. Width of index shaft at centre, 1·3 in. Width of medius shaft at centre, 2·3 in.

Figs. 16, 16 *a*, and 16 *b*.—Right index metatarsal bone.—B M.
Extreme length, 6·95 in. Width of shaft in centre, 1·25 in.

Figs. 17, 17 *a*, and 17 *b*.—Right medius metatarsal bone.—B.M.
Extreme length, 6·5 in. Width of shaft in centre, 1·9 in.

Figs. 18, 18 *a*, and 18 *b*.—Left medius metatarsal bone.—B.M.
Extreme length, 6·7 in. Width of shaft in centre, 2·05 in.

Figs. 19, 19 *a*, and 19 *b*.—Left annularis metatarsal bone.—B.M.
Extreme length, 5·6 in. Width of shaft in centre, 1·4 in.

Figs. 20, 20 *a*, 20 *b*, 20 *c*, and 20 *d*.—Medius metatarsal bone.—B.M.
Extreme length, 6·1 in. Width of shaft in centre, 2·3 in.

Figs. 21, 21 *a*, and 21 *b*.—Calcaneum.—B.M.
Extreme length, 5·8 in. Extreme height, 2·9 in. Extreme width, 3·6 in.

Figs. 22, 22 *a*, 22 *b*, and 22 *c*.—Cuboid bone.—B.M.
Greatest antero-posterior diameter of upper surface, 1·8 in. Greatest width of ditto, 2·35 in. Greatest height, 3· in.

Figs. 23, 23 *a*, 23 *b*, and 23 *c*.—Cuboid bone.
Greatest antero-posterior diameter of upper surface, 1·65 in. Greatest width of ditto, 2· in. Greatest height, 2·75 in.

Plate LXXX.

Chalicotherium Sivalense (Falc. and Caut.). See *antea*, page 208, and Pl. XVII.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Anterior half of an adult head, with the upper and lower jaws in natural apposition, and exhibiting the greatest portion of the dental series of both jaws. The greater part of the cranium proper is absent. The specimen demonstrates the very remarkable fact that the *Chalicotherium Sivalense* was entirely destitute of incisor teeth in either jaw. The intermaxillary bones are perfect to their tips, and consist of slender slips of bone converging to a sharp point; they show that no incisor teeth could have existed in the upper jaw at any period of the animal's age. The anterior portion of the lower jaw is perfect to the alveolar edge. A detached canine is seen on either side, but the intervening space is without a vestige of incisors, and is contracted in correspondence with the convergence of the intermaxillary bones, and sloped off to a fine edge. The upper jaw is also destitute of canines, or of any trace of canine alveoli; but the lower jaw contains two canines, as shown in figs. 1 *a* and 1 *b*, the crowns of which are thick, cuneiform, and somewhat triangular, and slightly inclined forwards, with a blunt apex. The specimen shows three premolars and the first true molar; the two back molars are absent. The characters of the molars are better seen in figs. 3 and 4, and are described in great detail in the memoir on Chalicotherium (Page 213).

This beautiful specimen was originally in the Dadoopoor collection of Messrs. Baker and Durand, and is now in the Museum of Marischal College, Aberdeen. Cast in B.M. Its dimensions are as follows :—

Length of intermaxillary bone of right side, 3· in. Greatest depth of ditto, ·4 in. Length of three premolars and first molar, 2·6 in. Length of three premolars, 1·8 in. Breadth of fragment opposite last premolar, 3·2 in. Breadth of palate ·5 in. in front of anterior premolar, 1·5 in. Breadth of palate 1·2 in. in front of anterior premolar, 1·1 in. Height of fragment of maxillary bone from alveolar border (right side), 2·5 in. Length of fragment of maxillary bone on right side, 3·9 in. Greatest breadth of anterior nares, 1·3 in. Extreme length of fragment of lower jaw, 5·5 in. Length of symphysis, 3·1 in. Depth of horizontal ramus at posterior border of first molar, 1·6 in. Greatest thickness of ramus at ditto, ·8 in. Interval between the horizontal ramus at ditto, 1· in. Breadth of lower jaw at posterior border of symphysis, 2·2 in. Least breadth of symphysis, 1·1 in. From posterior border of symphysis to narrowest part of symphysis, 1·9 in. Between alveolar border of canines, 1·2 in. Breadth of incisive margin, ·9 in. Width of palate posteriorly between first molars, 1·3 in. Length of first premolar, upper jaw, right side, ·5 in. Length of second premolar ditto, ·55 in. Length of third premolar (greatest) ditto, ·7 in. Length of first molar ditto, ·95 in. Breadth of first molar ditto, 1·03 in. Breadth of third premolar ditto, ·9 in. Breadth of second premolar ditto, ·76 in. Breadth of first premolar ditto, ·53 in. Length of three premolars and first molar, 2·8 in. Length of three premolars, 1·8 in. Between opposed margins of canine and first premolar, ·9 in. Between anterior margin of first premolar and incisive margin, 1·7 in. Length of first premolar, lower jaw, ·5 in. Length of second premolar, ditto, ·6 in. Length of third premolar, ditto, ·8 in. Length of first molar, ditto, 1·0 in. Breadth of first molar, ditto, ·6 in. Breadth of third premolar, ditto, ·5 in. Breadth of second premolar, ditto, ·43 in. Breadth of first premolar, ditto, ·3 in. Length of crown of canine, ·45 in. Breadth of crown of canine, ·3 in.

Fig. 2.—*Chalicotherium Sivalense*. Upper jaw, right side, with part of orbit, three true molars and last premolar. The muzzle seems to have fined off rather abruptly in front of the molar protuberances,

and the orbit to have been more forward on the face and more depressed below the brow than in *Anoplotherium commune*. The upper surface of the sub-orbitary canal is seen opening behind the anterior angle of the orbit, the floor of which seems to have extended behind the post-orbitary processes.—B.M.

This specimen is also figured as *Anoplotherium Sivalense* in the Proceedings Geol. Soc., No. 98, 1843, Plate II. fig. 2.

Figs. 3 and 3 *a*.—*Chalicotherium Sivalense*. Horizontal and lateral view of left upper jaw, comprising the three true molars and three premolars. The true molars, and especially the two last, are enormously large in comparison with the other teeth, or with the dimensions of the head. If found isolated, they would seem suitable to an animal approaching the size of Rhinoceros, whereas the anterior part of the lower jaw and the muzzle do not reach the dimensions of the Indian Tapir. The outer surface of the molars presents both vertically and horizontally the double chevron or W form of Anoplotherium, but with this difference, that the surface of the re-entering angles is more inclined inwards. The characters of the teeth in this specimen are minutely described in the memoir on Chalicotherium (See page 213).

This specimen is also figured in the Proceedings Geol. Soc. No. 98, 1843, Plate II. fig. 1.—B.M.

Figs. 4 and 4 *a*.—*Chalicotherium Sivalense*. Fragment comprising the left half of the lower jaw from the angle on to the commencement of the symphysis of an individual which was not quite full grown, containing three true molars and the last premolars, with the empty alveoli of the first two premolars. The last premolar is fully protruded, but unworn; the last molar is in the germ state. The characters of the teeth in this specimen are minutely described in the memoir on Chalicotherium.—B.M.

The dimensions of the specimen are as follows:—

Extreme length of fragment, 6·8 in. Greatest depth of ramus, 2·1 in. Greatest thickness (towards symphysis), 1·1 in. Depth of ramus at anterior margin of third premolar, 1·5 in. Length of alveolus of second premolar, ·55 in. Breadth of alveolus of ditto, ·35 in. Length of third premolar, ·7 in. Breadth of ditto, ·5 in. Length of first molar, ·8 in. Breadth of ditto, ·5 in. Length of second molar, 1·2 in. Breadth of ditto, ·65 in. Length of third molar, 1·5 in. Breadth of ditto, ·65 in.

PLATE LXXXI.

Figs. 1, 1 *a*, and 1 *b*.—*Equus Sivalensis* (Falc. and Caut.). Cranium. Upper, palate, and lateral views. The specimen is broken off transversely in front of the second premolar. The three true molars and two back premolars on the right side are well preserved. The left alveolar ridge is mostly deficient.—B.M. (See *antea*, p. 186.)

Length of fragment, 15· in. Between extreme points of zygomata, 8·1 in. Between anterior angles of the orbits, 6·2 in. Breadth of nasal ridge at sub-orbital foramen, 2·7 in. Height of cranium from palate at ditto, 3·3 in. From anterior angle of orbit to nasal notch, 6· in. Great diameter of orbit, 2·6 in. Lesser diameter of orbit, 1·9 in. Depth of zygomatic fossa, 1·8 in. Greatest width of cranium at root of zygomata, 4·5 in. Height of cranium from base of occipital to summit of sagittal crest, 3·6 in. From lower border of occipital foramen to posterior border of palate, 8·5 in. Length of three true molars, 3·1 in. Length of two posterior premolars, 2·2 in. Width of palatine notch, 1·9 in. Width of palate posteriorly, 3·3 in. Width of palate anteriorly, 2·5 in. Width of alveoli, 1·2 in.

Figs. 2, 2 *a*, and 2 *b*.—*Equus Sivalensis*. Fragment comprising posterior portion of skull, broken off in front in a line with anterior angles of zygomatic arches. Shows occipital foramen, crest, condyles, and posterior roots of zygomata.—B.M.

Length of fragment, 7·5 in. Height of occipital facet from lower border of occipital foramen to summit of occipital crest, 4·8 in. Between inferior angles of occipital crest, 4·7 in. Breadth of cranium between roots of zygomata, 3·7 in. Length of ridge of occipital condyle, 1·7 in. Height of condyle (greatest), 2·1 in. Between inner margins of condyles, 1·5 in. Height of occipital foramen, 1·6 in.

Fig. 3.—*Equus Sivalensis*. Fragment of upper jaw, with whole series of six molars.—B.M.

Length of fragment, 9·3 in. Height of fragment (length of molar), 4·1 in. Length of molar series, 7·7 in. Length of three true molars, 3·4 in. Breadth of alveoli, 1·3 in.

Fig. 4.—*Equus Sivalensis*. Fragment of horizontal ramus of lower jaw with whole series of six molars.—B.M.

Length of fragment, 11· in. Depth of jaw at anterior border of fourth premolar, 3·6 in. Width of ditto, 1·2 in. Length of molar series, 7·8 in. Length of three true molars, 3·7 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—*Equus Namadicus* (Falc. and Caut.), from the Nerbudda Valley. The occipital condyles and foramen and the left zygomatic arch are very perfect; also the whole series of six molars on left side. The specimen is broken off in front of first (permanent) premolar on left side; from this the line of fracture passes obliquely across the palate and through the middle of the hindmost right premolar. The three right true molars are present. The right zygomatic arch is absent.—B.M. (See *antea*, p. 186.)

Extreme length of fragment, 17·6 in. From lower border of occipital foramen to posterior border of palate, 9·6 in. Greatest breadth of cranium at roots of zygomatic processes, 4·4 in. Between extreme points of zygomata, 7·9 in. Between anterior angles of orbits, 6· in. Height of cranium from palate at fractured extremity, 3·6 in. Great diameter of orbit, 2·8 in. Lesser diameter of orbit, 1·8 in. Height of occipital facet from lower border of occipital foramen, 4·2 in. Between inferior angles of occipital facet, 4·1 in. Depth of zygomatic fossa, 1·7 in. Width of palatine notch, 1·7 in. Width of palate posteriorly, 3· in. Width of palate anteriorly, 2·7 in. Width of alveoli, 1·1 in. Length of molar series, 7· in. Length of true molars, 3·3 in.

Fig. 6.—*Equus Namadicus*. Fragment of left upper jaw comprising whole molar series.—B.M.

Length of fragment, 9·2 in. Length of molar series, 7· in. Length of three true molars, 3·2 in. Breadth of alveoli, 1·2 in.

Fig. 7.—*Equus Namadicus*. Fragment of left lower jaw with entire molar series. The fracture exposes the fang of the last true molar.—B.M.

Length of fragment, 12·7 in. Depth of jaw at anterior border of fourth premolar, 3·8 in. Width, 1·2 in. Length of molar series, 8· in. Length of three true molars, 3·8 in.

Plate LXXXII.

Fig. 1.—*Equus Sivalensis*. Upper jaw, right side, with entire molar series.—B.M.

Length of third molar, 1·16 in. Breadth of ditto, 1·03 in. Length of second molar, 1·16 in. Breadth of ditto, 1·2 in. Length of first molar, 1·16 in. Breadth

of ditto, 1·23 in. Length of third premolar, 1·23 in. Breadth of ditto, 1·3 in. Length of second premolar, 1·33 in. Breadth of ditto, 1·3 in. Length of first premolar, 1·7 in. Breadth of ditto, 1·2 in.

Fig. 2.—Lower jaw, right side, with entire molar series.

Length of third molar, 1·26 in. Breadth of ditto, ·6 in. Length of second molar, 1·2 in. Breadth of ditto, ·7 in. Length of first molar, 1·2 in. Breadth of ditto, ·8 in. Length of third premolar, 1·3 in. Breadth of ditto, ·8 in. Length of second premolar, 1·26 in. Breadth of ditto, ·83 in. Length of first premolar, 1·45 in. Breadth of ditto, ·73 in. Length of molar series, 7·65 in. Length of three true molars, 3·55 in.

Fig. 3.—*Equus Sivalensis.* Fragment of upper jaw, right side, with three true molars and two posterior premolars.—B.M.

Length of third molar, 1·25 in. Breadth of ditto, 1·05 in. Length of second molar, 1· in. Breadth of ditto, 1·15 in. Length of first molar, ·9 in. Breadth of ditto, 1·13 in. Length of third premolar, 1·15 in. Breadth of ditto, 1·2 in. Length of second premolar, 1·2 in. Breadth of ditto, 1·2 in. Length of molar series (first premolar wanting), 5·45 in. Length of three true molars, 3·15 in.

Fig. 4.—*Equus Sivalensis.* Fragment of lower jaw, including right horizontal ramus, with three anterior molars, milk dentition, and symphysis with outer incisor and alveoli of middle and inner incisors on either side.

Length of fragment, 9·3 in. Length of milk molar series, 4·15 in. Interval between first milk molar and external incisive alveolus, 3·75 in. Between central points of inner alveolar border of external incisors, 1·3 in. Length of third milk molar, 1·45 in. Breadth of ditto, ·56 in. Length of second milk molar, 1·25 in. Breadth of ditto, ·6 in. Length of first milk molar, 1·5 in. Breadth of ditto, ·63 in. Length of crown of external incisor, ·53 in. Breadth of crown of ditto, ·35 in. Length of alveolus of middle incisor, ·55 in. Length ditto of internal ditto, ·55 in. Between posterior angles of last milk molars, 2·16 in. Between anterior angles of anterior milk molars, 1·2 in.

Figs. 5 and 5 *a*.—*Equus Sivalensis.* Fragment, comprising anterior part of upper and lower jaws in almost natural apposition. Shows six incisors and two small canines in both jaws; also the two front premolars on one side of lower jaw.—B.M.

Between posterior angles of external incisors of lower figure in 5 *a*, 1·9 in. Length of crown of three incisors of one side, 1·2 in. Between anterior edge of mental foramen and anterior edge of canine, 2·4 in. Between anterior edge of mental for. and posterior edge of ext. incisors, 2·9 in. Diastema between canine and exterior incisor, ·4 in. Diastema between canine and anterior edge of first premolar, 3·3 in. Length of anterior premolar, 1·35 in. Breadth of ditto, ·6 in. Length of external incisor, ·5 in. Length of middle ditto, ·45 in. Length of internal ditto, ·35 in. Between posterior angles of exterior incisors of upper jaw in fig. 5 *a*, 2·2 in. Length of three incisors of one side, 1·8 in. Diastema between anterior premolar and canine, 3·2 in. Height of first premolar, 3· in. Length of external incisor, ·8 in. Length of middle ditto, ·8 in. Length of internal ditto, ·75 in.

Figs. 6, 6 *a*, and 6 *b*.—*Equus Sivalensis.* Fragment comprising anterior portion of palate, with six upper incisors and two rudimentary canines.—B.M.

Between posterior angles of external incisor alveoli, 2·45 in. Between external alveolar margins of canines, 2·1 in. Between canine and external incisor, ·4 in. Breadth (extreme) of incisor series, 2·8 in. Breadth of three incisors (oblique), 1·75 in. Length of crown of external incisor, ·7 in. Breadth of ditto, ·45 in. Length of crown of middle incisor, ·65 in. Breadth of ditto, ·46 in. Length of crown of internal incisor, ·56 in. Breadth of ditto, ·5 in.

Fig. 7.—*Equus Namadicus*, from the Nerbudda. Fragment of upper jaw, right side, with entire molar series.—B.M.

Length of molar series, 7·05 in. Length of three true molars, 3·2 in. Length of third molar, 1·15 in. Breadth of ditto, ·9 in. Length of second molar, 1·05 in. Breadth of ditto, 1·1 in. Length of first molar, ·96 in. Breadth of ditto, 1·05 in. Length of third premolar, 1·15 in. Breadth of ditto, 1·15 in. Length of second premolar, 1·16 in. Breadth of ditto, 1·1 in. Length of first premolar, 1·55 in. Breadth of ditto, 1·0 in.

Fig. 8.—*Equus Namadicus*. Fragment of lower jaw, left side, with entire molar series.—B.M.

Length of molar series, 7·93 in. Length of three true molars, 3·76 in. Length of third molar, 1·2 in. Breadth of ditto, ·5 in. Length of second molar, 1·2 in. Breadth of ditto, ·65 in. Length of first molar, 1·25 in. Breadth of ditto, ·7 in. Length of third premolar, 1·2 in. Breadth of ditto, ·7 in. Length of second premolar, 1·3 in. Breadth of ditto, ·73 in. Length of first premolar, 1·55 in. Breadth of ditto, ·66 in.

Figs. 9, 9 *a*, and 9 *b*.—*Equus Palæonus* (Falc. and Caut.), from the Nerbudda. Fragment of anterior portion of palate, with six incisors and two small canines. Presented by C. Frazer, Esq.—B.M.

Between inner alveolar margins of canines, 1·1 in. Diastema between canine and external incisor, ·8 in. Between posterior angles of external incisors, 1·7 in. Length of three incisors of one side, 1·6 in. Length of external incisor, ·6 in. Length of middle ditto, ·65 in. Length of internal ditto, ·56 in. Length of alveolus of canine on left side, ·4 in. Breath of ditto, ·3 in.

Figs. 10, 10 *a*, and 10 *b*.—*Equus Palæonus*. Fragment of anterior portion of lower jaw, with six incisors.—B.M.

Breadth across posterior margin of external incisive alveolus of left side, 2·4 in. Length of three incisors of one side, 1·45 in. Length of broken end of external incisor, ·45 in. Length of crown of middle incisor, ·5 in. Length of crown of internal ditto, ·4 in.

Figs. 11 and 11 *a*.—*Equus Palæonus*. Fragment of lower jaw, right side, milk dentition.—B.M. (See *antea*, p. 186, note.)

Length of third milk molar, grinding surface, 1·3 in. Breadth of ditto, ·36 in. Length of second milk molar, grinding surface, 1·15 in. Breadth of ditto, ·4 in. Length of first milk molar, grinding surface, 1·2 in. Breadth of ditto, ·4 in.

Figs. 12, 12 *a*, and 12 *b*.—Fossil *Equus*, from the Irrawaddi. Fragment of lower jaw, comprising symphysis and six incisors.—B.M.

Length of fragment, 4·4 in. Between external angles of external incisors, 2·4 in. Length of three incisive alveoli of one side, 1·5 in.

Fig. 13.—*Hippotherium Antilopinum* (Falc. and Caut.), from the Sewalik hills. Fragment of upper jaw, left side, with entire series of six molars.—B.M. (See *antea*, p. 186.)

Length of molar series, 5·3 in. Length of three true molars, 2·36 in. Length of third molar, ·8 in. Breadth of ditto, ·55 in. Length of second molar, ·85 in. Breadth of ditto, ·76 in. Length of first molar, ·8 in. Breadth of ditto, ·85 in. Length of third premolar, ·93 in. Breadth of ditto, ·86 in. Length of second premolar, ·96 in. Breadth of ditto, ·95 in. Length of first premolar, 1·25 in. Breadth of ditto, ·83 in. Height of second premolar, 2·15 in. Height of first premolar to origin of fangs, 1·4 in.

Fig. 14.—*Hippotherium Antilopinum*. Fragment of lower jaw, right side, with three premolars and portion of first true molar.—B.M.

Length of three premolars, 3·1 in. Length of three premolars and first molar (fragment), 4·1 in. Remaining portion of diastema, 1·8 in. Length of first molar (fragment), ·8 in. Breadth of ditto, ·55 in. Length of third premolar, ·96 in. Breadth of ditto, ·6 in. Length of second premolar, ·96 in. Breadth of ditto, ·55 in. Length of first premolar, 1·05 in. Breadth of ditto, ·5 in.

Figs. 15, 15 *a*, and 15 *b*.—*Hippotherium Antilopinum*. Symphysis of lower jaw, with fragments of six incisors.—B.M.

Length of fragment, 2·2 in. Breadth at anterior angles of canines, 1·6 in. Length of fragments of three incisors of one side, ·95 in.

Fig 16.—*Hippotherium Antilopinum*. Portion of skull, with palate. Shows three true molars and third (permanent) premolar on both sides, and portion of second premolar on right side.—B.M.

Length of three true molars, 2·5 in. Length of three true molars, including last premolar, 3·36 in. Width of palate posteriorly, 2·in. Width of palate between third premolars, 1·9 in. Length of third molar, ·85 in. Breadth of ditto, ·75 in. Length of second molar, ·8 in. Breadth of ditto, ·85 in. Length of first molar, ·8 in. Breadth of ditto, ·9 in. Length of third premolar, ·9 in. Breadth of ditto, ·9 in.

Fig. 17.—*Hippotherium Antilopinum*. Portion of molar, showing plication of enamel.—B.M.

Length of fragment, ·75 in. Breadth, ·45 in.

Fig. 18.—*Hippotherium Antilopinum*. Molar, with characteristic plication of the enamel, like that shown in fig. 19.[1]

Length of grinding surface, ·85 in. Greatest breadth of ditto, ·85 in.

Fig. 19.—*Hippotherium gracile* (of Europe). Molar, with characteristic plication of enamel.

Greatest length of grinding surface, 1·03 in. Greatest breadth of ditto, ·975 in.

Plate LXXXIII.

Figs. 1 to 11.—*Equus* and *Hippotherium*.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Atlas.—B.M.

Extreme width, 4·5 in. Length of inferior arch, 1·4 in. Height of spinal canal anteriorly, 1·5 in. Width of ditto, 1·7 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—Axis.—B.M.

Extreme length of body, 4·1 in. Length of spinal platform in centre, 2·5 in. Width across posterior articular processes, 2·8 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Cervical vertebra.—B.M.

Extreme length of body, 4·4 in. Between extremities of oblique processes, 4·5 in. Width between posterior oblique processes, 2·6 in.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—Cervical vertebra.—B.M.

Extreme length between extremities of oblique processes, 4· in. Width of spinal platform in centre, 1·7 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Cervical vertebra.—B.M.

Extreme length of body, 4·3 in.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Dorsal vertebra.—B.M.

Length of spine (fractured), 6·5 in. Length of body, 2·2 in. Width between transverse processes, 3·8 in.

Fig. 7.—Portion of pelvis, showing acetabulum.—B.M.

Chord of acetabulum, 2·4 in.

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[1] This specimen somewhat resembles that figured by Messrs. Baker and Durand in Journ. As. Soc., vol. iv., Plate xlv., and described by Dr. Falconer in same volume, p. 58.

Fig. 8.—Portion of pelvis, showing acetabulum and thyroid foramen. —B.M.

Chord of acetabulum, 2· in. Diameter of thyroid foramen (anterior portion), 2·3 in.

Figs. 9, 9 *a*, and 9 *b*.—Lower end of humerus and upper end of radius and ulna *in situ*.—B.M.

Width of lower end of humerus, 3·1 in. Width of upper end of radius, 3·2 in. Antero-posterior diameter of lower end of humerus internally, 3·4 in.

Figs. 10, 10 *a*, 10 *b*, and 10 *c*.—Fragment of lower articulating extremity of femur.—B.M.

Width of lower extremity of femur, 2·9 in. Antero-posterior diameter of femur externally, 3·2 in. Width of rotular surface, 1·5 in.

Figs. 11, 11 *a*, 11 *b*, and 11 *c*.—Lower end of femur.—B.M.

Width of lower end, 3·5 in.

Figs. 12, 12 *a*, and 12 *b*.—*Hippopotamus* (*Hexaprotodon*) *Iravaticus*. Lower end of radius.—B.M.

Width of lower end, 2·8 in. Antero-posterior diameter of ditto, 1·7 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Second cervical vertebra or axis. Species undetermined. From Col. Baker's collection.—B.M.

Extreme length of body (fractured), 5·5 in. Width of odontoid surface, 3·2 in. Width between outer edges of posterior articular surfaces, 3·5 in.

Figs. 14, 14 *a*, 14 *b*, and 14 *c*.—Fragment of lower end of femur. Species undetermined.—B.M.

Circumference above rotular surface, 8· in. Width of rotular surface, 1·5 in.

PLATE LXXXIV.

Figs. 1 and 1 *a*.—*Equus Sivalensis*. Upper articulating extremity, and portion of shaft of ulna.—B.M.

Width of radial articular surface, 3·2 in. Chord of sigmoid cavity, 1·55 in. From apex of olecranon to anterior edge of sigmoid cavity, 5·7 in.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—*Equus Sivalensis*. Upper end and portion of shaft of ulna.—B.M.

Width of radial articular surface, 3·1 in. Circumference at lower fractured extremity, 5·2 in.

Figs. 3, 3 *a*, and 3 *b*.—*Equus Sivalensis*. Fragment of lower end of radius.—B.M.

Width of inferior articulating surface, 2·8 in. Greatest antero-posterior diameter, 1·5 in.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—*Equus Sivalensis*. Metacarpal bone. Entire shaft and lower articulating surface.—B.M.

Extreme length, 10· in. Width of upper articular surface, 2·1 in. Width of lower, 1·8 in. Circumference of shaft in centre, 4·1 in.

Figs. 5, 5 *a*, and 5 *b*.—*Hippotherium Antilopinum*. Fragment of upper end of radius.—B.M.

Width of upper articulating surface, 2·5 in.

Figs. 6, 6 *a*, and 6 *b*.—*Hippotherium Antilopinum*. Fragment of lower end of radius.—B.M.

Width of lower articular surface, 1·85 in.

Figs. 7, 7 *a*, and 7 *b*.—*Hippotherium Antilopinum.* Fragment of lower end of radius with bones of carpus.—B.M.

Width of inferior articulating surface of radius, 2·1 in.

Figs. 8 and 8 *a*.—*Hippotherium Antilopinum.* Lower end of radius, with bones of carpus, and portion of metacarpus.

Figs. 9, 9 *a*, 9 *b*, and 9 *c*.—*Hippotherium Antilopinum.* Metacarpal bone.—B.M.

Extreme length, 8·8 in. Width of upper articular surface, 1·5 in. Width of lower articular surface fractured, 1·5 in. Circumference in centre of shaft, 3·2 in.

Figs. 10, 10 *a*, and 10 *b*.—*Hippotherium Antilopinum.* Fragment of metacarpal bone; lower end broken off.—B.M.

Length of fragment, 8·1 in. Width of articular surface of middle metacarpal, 1·65 in. Width of articular surface of left metacarpal, ·4 in. Width of articular surface of right ditto, ·35 in.

Figs. 11 and 11 *a*.—*Hippotherium Antilopinum.* First phalanx.—B.M.

Length, 2·9 in. Greatest width of upper articular surface, 1·7 in. Greatest width of lower ditto, 1·3 in.

Figs. 12, 12 *a*, 12 *b*, and 12 *c*.—*Hippotherium Antilopinum.* Second phalanx.—B.M.

Length, 1·5 in. Greatest width of upper articular surface, 1·4 in. Greatest width of lower ditto, 1·25 in.

Figs. 13, 13 *a*, 13 *b*, 13 *c*, and 13 *d*.—Radius of fossil Equus from the Nerbudda, entire.—B.M.

Greatest length of radius, 11·4 in. Width of upper articular surface, 2·7 in. Width of lower articular surface, 2·15 in. Circumference of shaft in centre, 5· in.

Figs. 14, 14 *a*, and 14 *b*.—Shaft of radius of fossil Equus from the Nerbudda. The articulating extremities are imperfect.—B.M.

Length of fragment, 10·7 in. Circumference of shaft in centre, 4·3 in.

Figs. 15, 15 *a*, and 15 *b*.—Equus from the Niti Pass. Upper end of shaft with articulating extremity of radius.—B.M.

Width of upper articulating surface, 2·45 in.

Figs. 16, 16 *a*, and 16 *b*.—Equus from the Niti Pass. Fragment of lower end of tibia.

Width of lower surface, 1·9 in.

Figs. 17 and 17 *a*.—Equus from the Niti Pass. Astragalus.—B.M.

Width of trochlea, 1·45 in. Antero-posterior diameter of ditto, 1·3 in. Width of scaphoid surface, 1·7 in.

Figs. 18, 18 *a*, and 18 *b*.—Equus from the Niti Pass. Os magnum of carpus.—B.M.

Transverse diameter, 1·4 in. Antero-posterior diameter, 1·15 in. Thickness in centre, ·7 in.

Figs. 19, 19 *a*, and 19 *b*.—Equus from the Niti Pass. Third or ungual phalanx.—B.M.

Width of articular surface, 1·55 in. Probable antero-posterior diameter, 2·1 in.

Figs. 20 and 20 *a*.—Equus. Metatarsal bone from Sewalik hills.—B.M. No. 17,828.

Extreme length, 11·1 in. Width of upper articular surface, 2· in. Width of lower ditto, 1·8 in. Circumference at middle of shaft, 4·4 in.

Fig. 21.—Equus. Metatarsal bone from Sewalik hills.—B.M.

Circumference in centre of shaft, 3·8 in.

Plate LXXXV.

Figs. 1, 1 *a*, 1 *b*, 1 *c*, and 1 *d*.—*Equus Sivalensis.* Entire femur, with both articulating extremities.—B.M.

Extreme length, 15·6 in. Transverse diameter of upper extremity, including trochlea, 4·6 in. Antero-posterior diameter of posterior segment of great trochlea, 1·9 in. Transverse diameter of articular surface, 2·5 in. Antero-posterior diameter of articular surface, 2·1 in. Smallest transverse diameter of shaft, 1·8 in. Smallest antero-posterior diameter of shaft, 1·9 in. Transverse diameter of lower extremity, 3·6 in. Antero-posterior diameter externally, 3·6 in. Height of rotular surface in centre, 2·4 in. Height of external condyle above neck of femur, 1·8 in.

Figs. 2, 2 *a*, and 2 *b*.—*Equus Sivalensis.* Upper end of shaft of femur, with upper articular extremity.

Length of fragment, 6·8 in. Breadth of upper extremity, 4·3 in. Transverse diameter of articular surface, 2·2 in. Antero-posterior diameter of ditto, 1·9 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—*Equus Sivalensis.*—Entire tibia.—B.M.

Extreme length, 14·5 in. Transverse diameter of upper extremity, 3·5 in. Transverse diameter of shaft (smallest), 1·7 in. Antero-posterior diameter of shaft (smallest), 1·2 in. Transverse diameter of lower extremity, 3· in. Length of ridge dividing articular fossæ, 2·4 in.

Fig. 4.—Lower end of tibia and astragalus of Equus *in situ*, restoration.

Figs. 5, 5 *a*, and 5 *b*.—Calcaneum of *Equus Sivalensis.*—B.M.

Length, 5·8 in. Projection of heel, 3·2 in. Greatest breadth, 2·1 in. Greatest height, 1·9 in.

Figs. 6, 6 *a*, and 6 *b*.—Astragalus of *Equus Sivalensis.*—B.M.

Length (greatest), 2·5 in. Height (greatest), 1·9 in. Breadth of scaphoid surface, 2·1 in. Breadth of trochlea (tibial surface), 1·7 in. Antero-posterior diameter of trochlea in centre, 1·4 in.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Metatarsal bone of *Equus Sivalensis.*

Extreme length, 11·5 in. Antero-posterior diam. of shaft in centre, 1·2 in. Transverse of shaft ditto, 1·3 in. Transverse of upper extremity, 2· in. Antero-posterior of ditto, 1·7 in. Transverse of lower articular surface, 1·8 in. Greatest antero-posterior of lower articular surface (in centre), 1·5 in.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—First phalangeal bone posterior extremity of *Equus Sivalensis.*—B.M.

Length superiorly, 3·1 in. Transverse diam. of posterior extremity, 2·1 in. Vertical of ditto, 1·3 in. Transverse of anterior articular surface, 1·5 in. Vertical of ditto, ·9 in.

Figs. 9, 9 *a*, and 9 *b*.—*Hippotherium Antilopinum.* Fragment of shaft of tibia with lower articulating extremity.—B.M.

Length, 5· in. Breadth of inferior articular surface, 2·4 in. Length of ridge dividing articular fossæ, 1·8 in.

Figs. 10, 10 *a*, and 10 *b*.—Astragalus of *Hippotherium Antilopinum.*—B.M.

Length, 2· in. Breadth of scaphoid surface, 1·6 in. Breadth of tibial surface, 1·3 in. Length of tibia (in centre), 1·2 in.

Figs. 11, 11 *a*, and 11 *b*.—Tarsus, metatarsus, and phalanx of *Hippotherium Antilopinum.*—B.M.

Length of whole figure, 15·3 in.

Figs. 12, 12 *a*, 12 *b*, and 12 *c*.—Metatarsal bone of *Hippotherium Antilopinum*.—B.M.

Length, 10·4 in. Smallest transverse diameter of shaft, 1· in. Smallest antero-posterior diameter of shaft, ·9 in. Transverse of upper extremity, 1·6 in. Antero-posterior of ditto, 1·4 in. Transverse of lower extremity, 1·4 in. Antero-posterior of lower central ridge, 1·2 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Portion of metatarsal bone and first two phalanges of *Hippotherium Antilopinum*.—B.M.

Transverse diameter of inferior extremity of metatarsal, 1·5 in. Length of first phalanx, 2·7 in.; of second, 1·5 in. Antero-posterior diameter of lower extremity of metatarsal, 1· in.

Figs. 14, 14 *a*, and 14 *b*.—First phalanx of posterior extremity of *Hippotherium Antilopinum*.—B.M.

Length, 3·1 in. Transverse diameter of posterior extremity, 1·6 in. Vertical diameter of ditto, ·9 in. Transverse diameter of anterior extremity, 1·3 in. Vertical diameter of anterior extremity, ·6 in.

Figs. 15, 15 *a*, and 15 *b*.—Second phalanx of posterior extremity of *Hippotherium Antilopinum*.—B.M.

Length, 1· in. Transverse of posterior extremity, 1·5 in. Vertical of ditto, 1· in. Transverse of anterior extremity, 1·3 in. Vertical of ditto, ·7 in.

Figs. 16, 16 *a*, and 16 *b*.—Last phalanx of posterior extremity of *Hippotherium Antilopinum*.—B.M.

Length of fragment, 1·6 in. Greatest breadth, 1·8 in. Height, 1· in.

Fig. 17.—Lower end of tibia and astragalus of *Hippotherium Antilopinum*, restored.

Figs. 18, 18 *a*, and 18 *b*.—Calcaneum of *Hippotherium Antilopinum*.

Greatest length, 4· in.

Plate LXXXVI.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Camelus Sivalensis*. (Falc. and Caut.) Mutilated fragment of cranium broken off in front through the first true molar. The great elevation of the sagittal and occipital crests, the development of the temporal fossæ, and the advanced position and prominence of the orbits, are to be noted. The orbits also are elongated from before backwards, instead of being circular or elongated vertically as in the existing Camel.—B.M. (See Memoir on 'Camel,' *antea*, p. 227.)

Height of occipital facet, 4·2 in. Width between extreme parts of occipital condyles, 3· in. Height of for. magnum, 1·5 in. Width of ditto, 1·3 in. Between pariet. occipital angles, 4·3 in. From lower angle of for. magnum to posterior border of last molar, 6·1 in. Width of palate between anterior angles of last molars, 2·8 in. Width across widest part of cranial cavity, 4·7 in. Between external aud. canal and posterior border of orbit, 4·8 in. Antero-posterior diameter of orbit, 2·7 in. Vertical diameter of ditto, 1·7 in. Width across at posterior extremity of zygomatic arches, 8·4 in. Width across at posterior angles of orbits, 9·5 in.

Figs. 2, 2 *a*, and 2 *b*.—*Camelus Sivalensis*. Fragment of cranium showing palate with series of true molars on both sides. The specimen also shows the extreme depth of the maxillary which leads to the arched appearance in the nose of the Camel.—B.M.

Length of true molar series, 4·8 in. Width of palate between posterior angles of last molars, 3·2 in. Width of palate between anterior angles of anterior molars, 2· in.

Fig. 3.—*Camelus Sivalensis*. Skull and lower jaw. Both jaws are

locked together, but the anterior and posterior extremities with the upper surface of the skull are wanting. The animal was young, its last permanent molars not being completely developed, and the third milk molar being still in position. The general character is that of the present Camel; the form of maxillaries, thickness of lower jaw and external appearance of the teeth corresponding as closely as two skulls of one species would do. The position of the sub-orbitary foramen, however, is rather higher up on the maxillary, and the tapering of the lower jaw is less than in the existing Camel. This specimen is also figured in 'Asiatic Researches,' vol. xix. Plate XX. fig. 3.—B.M. (See *antea*, p. 232, and Pl. XVIII. fig. 2.)

Length of molar series (including two last premolars), 6·2 in. Length of three true molars, 4·8 in. Height of ramus of lower jaw opposite last molar, 2·7 in. Thickness of ramus of lower jaw opposite last molar, 1·35 in. Length of molar series of lower jaw (including last premolar), 6·3 in. Length of true molar of lower jaw, ditto, 5·6 in.

Figs. 4 and 4 *a*.—*Camelus Sivalensis*. Cranium including occiput and nasal bones. The great width and massiveness of the cranium as compared with the muzzle are well seen, and also the antero-posterior elongation of the orbit.—B.M. (See *antea*, p. 232, and Pl. XVIII. fig. 1.)

Antero-posterior diameter of orbit, 2·3 in. Height of ditto, 1·6 in. Between anterior angle of orbit and sub-orbital foramen, 2·3 in. Length of first and second true molars, 2·6 in. Widest part of cranial box, 3·7 in.

Figs. 5 and 5 *a*.—*Camelus Sivalensis*. Lower jaw, which on the right side, with the exception of the condyle and coronoid process, is almost perfect. Fragments containing molars of upper jaw are still in apposition at some places. The specimen shows four incisors on the left side; the third right incisor is wanting. The wear of the teeth and the flattened surface of the fourth or pointed incisor show that the animal must have been of considerable age. This specimen is also figured in the 'Asiatic Researches,' vol. xix. Plate XX. fig. 4, a larger quantity of matrix containing remains of upper jaw being there still adherent.—B.M. (See *antea*, p. 232, and Pl. XVIII. figs. 3 and 4.)

Between outer margins of canines, 2·5 in. Between outer margins of first premolars, 2·1 in. Diastema between canine and first premolar, ·7 in. Length of the molar series, 5·9 in. Diastema between first and last premolar, 3· in. Length of the three true molars, 4·9 in. Length of symphysis, 5·3 in. Interval between rami opposite last molars, 2·6 in.

Plate LXXXVII.

Camelus Sivalensis.

Figs. 1 and 1 *a*.—Palate with molar series on both sides imperfect. That on the right side is most complete, and contains the penultimate and last deciduous molar and the two first true molars.—B.M.

Length of molar series, 4·9 in. Length of penultimate milk molar, 5 in. Length of last deciduous molar, 1·3 in. Length of first true molar, 1·6 in. Length of second true molar, 1·9 in.

Figs. 2 and 2 *a*.—Fragment of upper jaw, left side, containing three true molars.—B.M.

Length of true molar series, 4·9 in. Length of first molar, 1·3 in. Length of second ditto, 1·6 in. Length of third ditto, 1·9 in. Width of grinding surface of first true molar, 1·1 in.

Figs. 3 and 3 *a*.—Fragment of upper jaw, left side, showing the

second and third true molars. This specimen is also figured in 'Asiatic Researches,' vol. xix. Plate XXI. figs. 12 and 13.—B.M. (See *antea*, p. 234, and Pl. XVIII. fig. 5.)

Length of second true molar, 1·65 in.; of third ditto, 2· in.

Figs. 4 and 4 *a*.—Fragment of upper jaw, containing third and fourth premolars.—B.M.

Length of third premolar, ·85 in.; of fourth, ·95 in.

Figs. 5 and 5 *a*.—Fragment of horizontal ramus of lower jaw, containing three true molars and fourth premolar.—B.M.

Length of molar series of lower jaw, 5·7 in. Length of true molar ditto, 4·7 in. Length of fourth premolar, 0·9 in. Length of first molar, 1·2 in. Length of second ditto, 1·4 in. Length of third ditto, 2·1 in. Length of last lobe of third molar, ·6 in.

Figs. 6 and 6 *a*.—Fragment of lower jaw, right side, with ascending ramus, condyle, and coronoid process, and containing last molar. The jaw exhibits remarkable differences from the jaw of the existing Camel. It more resembles the lower jaw of Ox, Deer, or Antelope, but is shown to be of Camel by the heel or step on the posterior ascending margin, which is the generic mark of a Camel. In the existing Camel the ascending ramus rises at nearly a right angle to the line of jaw; it has considerable breadth antero-posteriorly, and its coronoid process is short, straight, and massive. In the fossil the ascending ramus is as oblique as in the Ox; it has no excess of breadth antero-posteriorly, and the coronoid process is long, slightly curved back, and slender. The condyle also has a much longer transverse diameter, its proportions are more slender, and the depression on its upper margin much deeper than in the existing Camel. The condyles, however, are not nearly so slight and narrow as in the Ox and Buffalo. This specimen is also figured in 'Asiatic Researches,' vol. xix. Plate XX. figs. 6 and 7.—B.M. (See *antea*, p. 235.)

Length of last molar, 2·25 in. Length of last lobe of ditto, ·7 in.

Figs. 7 and 7 *a*.—Fragment of horizontal ramus of lower jaw, containing fourth premolar, and the two first and a fragment of third true molars.—B.M.

Length of fourth premolar, ·85 in. Length of first molar, 1·4 in. Length of second ditto, 1·8 in. Length of fragment of third ditto, 1·6 in.

Figs. 8 and 8 *a*.—Fragment of horizontal ramus of lower jaw, containing penultimate and last milk molars and first true molar.—B.M.

Length of penultimate milk molar, ·6 in. Length of last milk molar, 1·7 in. Length of last lobe of ditto, ·7 in. Length of first true molar, 1·6 in.

Figs. 9 and 9 *a*.—Symphysis of lower jaw with series of six incisors. The fourth incisor, or canine, on left side, also seen.—B.M.

Chord of the incisor series, 2·65 in. Length of first incisor, ·7 in. Length of second ditto, ·73 in. Length of third ditto, ·6 in.

Figs. 10, 10 *a*, and 10 *b*.—Symphysis of lower jaw with alveoli of six incisors and two canines (fourth incisors).—B.M.

Width between outer margin of external incisive alveoli, 1·8 in. Width between outer margin of canine ditto, 1·7 in.

Figs. 11 and 11 *a*.—Symphysis of lower jaw with six incisors and two canines (fourth incisors).—B.M.

Chord of incisor series, 1·55 in. Width between canine alveoli, 1·5 in. Length of first incisor, 0·5 in. Length of second ditto, 0·55 in. Length of third or external, 0·65 in.

Plate LXXXVIII.

Vertebræ of *Camelus Sivalensis*.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Atlas with portion of axis adherent to lower end.—B.M.

Length of lower arch of atlas, 2·6 in. Length of upper ditto, 3·1 in. Extreme length of atlas, 4·4 in. Between outer margin of posterior articular processes, 3·6 in.

Figs. 2, 2 *a*, 2 *b*, 2 *c*, and 2 *d*.—Third cervical vertebra.—B.M.

Greatest length of body, 7·7 in. Height of spinal canal posteriorly, 1· in. Width of spinal canal ditto, 1·3 in.

Figs. 3, 3 *a*, 3 *b*, 3 *c*, and 3 *d*.—Fourth cervical vertebra.—B.M.

Length of body, 7·8 in. Length of spinal platform, 5·5 in. Length between extremities of oblique processes, 8·5 in. Between extremities of inferior transverse processes anteriorly, 4·6 in.

Figs. 4, 4 *a*, 4 *b*, 4 *c*, and 4 *d*.—Fifth cervical vertebra.—B.M.

Greatest length of body, 6·9 in. Width of spinal canal anteriorly, 1·1 in. Height of spinal canal anteriorly, 1· in. Between outer margins of vertebral foramina, 1·95 in. Diameter of vertebral foramen, 0·4 in. Probable width across transverse processes, 3·8 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Cervical vertebra imperfect.—B.M.

Length of fragment of body, 3·9 in. Height of spinal canal posteriorly, 1·2 in. Width of spinal canal ditto, 1·2 in.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Cervical vertebra.—B.M.

Greatest length of body, 4·65 in. Height of spinal canal posteriorly, 1·3 in. Width of spinal canal ditto, 1·5 in.

Plate LXXXIX.

Bones of anterior extremity of *Camelus Sivalensis*.

Fig. 1.—Scapula, almost perfect.—B.M.

Length of scapula, 22· in. Width at narrowest part, 3·2 in. Height of coracoid process, 2·3 in. Greatest projection of spine, 1·6 in.

Fig. 2.—Glenoid cavity of scapula.

Greater diameter, 2·6 in. Lesser ditto, 2·3 in.

Figs. 3, 3 *a*, and 3 *b*.—Head of humerus, with double bicipital groove.—B.M.

Greatest antero-posterior diameter, 5· in. Greatest transverse ditto, 4·6 in. Chord of double bicipital groove, 3· in.

Fig. 4.—Head of humerus, with double bicipital groove.—B.M.

Greatest antero-posterior diameter, 4·6 in. Greatest transverse ditto, 3·6 in. Chord of double bicipital groove, 2·7 in.

Figs. 5, 5 *a*, and 5 *b*.—Lower end of humerus, with articular surface.—B.M.

Transverse diameter of inferior articular surface, 3·6 in. Antero-posterior diameter internally of inferior extremity, 4· in. Length of fragment, 7·1 in.

Figs. 6, 6 *a*, and 6 *b*.—Lower end of humerus and upper end of conjoined radius and ulna *in situ*.—B.M.

Width of inferior articular surface of humerus, 3·3 in. Width of superior articular surface of radius, 3·45 in.

Figs. 7, 7 *a*, and 7 *b*.—Portion of shaft and lower articulating extremity of conjoined radius and ulna.—B.M.

Width of conjoined lower extremity of radius and ulna, 2·9 in. Circumference of conjoined shafts at fractured extremity, 5·9 in. Length of fragment, 7·3 in.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—Lower end of conjoined radius and ulna, with carpal and metacarpal bones.—B.M.

Extreme width of lower conjoined articular surface of radius and ulna, 3·8 in. Greatest antero-posterior diameter of ditto, 2·1 in. Extreme length of fragment of metacarpal, 14·55 in. Width of upper articular surface of metacarpal, 3·3 in. Greatest transverse diameter of shaft at centre, 1·8 in. Least antero-posterior diameter of shaft at centre, 1·4 in.

Fig. 9.—Lower end of radius and ulna with bones of carpus.—B.M.

Greatest length of pisiform, 2·1 in. Height, 2· in.

Figs. 10, 10 *a*, 10 *b*, and 10 *c*.—Bones of carpus.—B.M.

Figs. 11 and 11 *a*.—Fragment of upper end of metacarpal bone.—B.M.

Length, 12· in. Width of upper articular surface of ditto, 2·9 in. Greatest transverse diameter at centre of shaft, 1·6 in. Least antero-posterior diameter at centre of shaft, 1·3 in.

Figs. 12, 12 *a*, 12 *b*, and 12 *c*.—Lower articulating extremity of metacarpal bone, deeply fissured.—B.M.

Extreme length of fragment, 5·6 in. Interval between articular surfaces, ·5 in. Greatest width of articular surface, 1·85 in. Greatest antero-posterior of articular surface in centre, 1·9 in. Circumference of shaft at fractured extremity, 5·9 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—First phalanx and sesamoid bone.—B.M.

Length of first phalanx, 3·9 in. Width of proximal articular surface, 1·6 in. Greatest width of distal surface, 1·5 in. Length of articular surface of sesamoid bone, 1· in. Width of articular surface of sesamoid bone, ·7 in.

Figs. 14, 14 *a*, 14 *b*, and 14 *c*.—First phalanx.—B.M.

Length of first phalanx, 4· in. Width of upper articular surface, 1·9 in. Width of lower articular surface (greatest), 1·6 in.

Plate XC.

Bones of posterior extremity of *Camelus Sivalensis*.

Figs. 1, 1 *a*, and 1 *b*.—Fragment of head of femur.—B.M.

Antero-posterior diameter of great trochanter, 2·9 in.

Figs. 2 and 2 *a*.—Articulating surface of head of femur.—B.M.

Diameter of articulating surface, 2·5 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Fragment of lower end of femur with condyles.—B.M.

Length of fragment, 6·6 in. Width of lower extremity, 4·8 in.

Figs. 4, 4 *a*, and 4 *b*.—Fragment of lower end of femur.—B.M.

Transverse diameter of lower extremity, 3·8 in. Width of rotular surface, 2·2 in. Height of rotular surface in centre, 2·7 in.

Figs. 5, 5 *a*, and 5 *b*.—Fragment of lower end of femur.

Width of lower extremity, 4·6 in. Width of rotular surface in centre, 1·6 in. Height of rotular surface in centre, 2·6 in.

Figs. 6, 6 *a*, and 6 *b*.—Patella.—B.M.

Length, 3·7 in. Width, 2·9 in. Width of articular surface in centre, 1·4 in.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Entire tibia.—B.M.

Extreme length of tibia, 16·7 in. Extreme width of upper articular surface, 3·6 in. Width of inferior articular surface posteriorly, 2·3 in. Circumference of shaft below crest, 6· in.

Figs. 8, 8 *a*, 8 *b*, 8 *c*, and 8 *d*.—Calcaneum and cuboid.—B.M.

Extreme length of calcaneum, 6·7 in. Projection of calcaneal process, 4·3 in. Greatest height, 3·1 in. Height of cuboid, 2·2 in. Greatest width superiorly, 1·7 in. Antero-posterior diameter, 1·5 in.

Fig. 9.—Tarsal bones, conjoined. *a*. calcaneum; *b*. astragalus; *c*. scaphoid; *d*. internal cuneiform; *e*. external cuneiform.—B.M.

Figs. 10, 10 *a*, 10 *b*, 10 *c*, and 10 *d*.—Astragalus.—B.M.

Extreme antero-posterior diameter, 3·4 in. Width of anterior articular surface, 2·3 in. Width of cuboid segment of ditto, ·9 in. Width of trochlea, 2·1 in. Height, 1·95 in.

Fig. 11.—Astragalus.—B.M.

Extreme height, 2·8 in. Width of anterior articular surface, 1·8 in. Width of cuboid segment of ditto, ·6 in. Width of trochlea, 1·6 in. Height of astragalus, 1·55 in.

Figs. 12 and 12 *a*.—Upper extremity of metatarsal bone.—B.M.

Extreme width of upper articular surface, 2·2 in. Antero-posterior diameter in centre of upper extremity, 1·8 in.

Figs. 13, 13 *a*, and 13 *b*.—Metatarsal bone, entire; lower end deeply fissured.—B.M.

Length, 16· in. Width of upper articular surface, 2·3 in. Width of each of lower articular surfaces, 1·3 in. Interval between them, ·35 in. Antero-posterior diameter of each, 1·5 in. Greatest transverse diameter of shaft in centre, 1·45 in. Antero-posterior diameter of ditto, 1·3 in.

Figs. 14, 14 *a*, 14 *b*, and 14 *c*. First phalanx.—B.M.

Length, 4· in. Width of proximal surface, 1·55 in. Width of distal articular surface, 1·45 in.

Figs. 15, 15 *a*, 15 *b*, and 15 *c*.—Second phalanx.—B.M.

Extreme length, 2·4 in. Width of upper articular surface, 1· in. Extreme width of distal ditto, 1·15 in.

Plate XCI.

Sivatherium giganteum (Falc. and Caut.), from the Sewalik hills. (See *antea*, p. 247.) Splendid specimen of cranium, anterior view, from Sir Proby Cautley's collection in British Museum. A full description of this specimen, with measurements, will be found in the Memoir on Sivatherium (See p. 256).—B.M. (Reproduced in Pl. XIX.)

Plate XCII.

Sivatherium giganteum.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Four different views of same cranium as figured in Plate XC.—B.M. (Figs. 1 *a* and 1 *b* reproduced in Pl. XX.)

Figs. 2 and 2 *a*.—Fragment of cranium showing orbit and temporal fossa, basilar process of occipital, depressions for condyles of lower jaw, &c. This is the same specimen as is figured in Plate A. fig. 3, under which the dimensions will be found.—B.M.

[Plate XCII. completes the series of published plates. Copies of the seventeen plates which follow, and which I have designated by letters (A. to R.), were found among Dr. Falconer's papers, or have been furnished by Mr. Ford, the artist and lithographic engraver. These plates had been executed on stone, and proof impressions struck off; but the plates were never published, and unfortunately the stones were destroyed during Dr. Falconer's absence in India. These seventeen plates have been deposited in the library of the Geological Department in the British Museum, and from them several of the specimens in the Museum have been named. Through the kindness of Mr. Davies, I am enabled to give the British Museum Catalogue number for each of the specimens figured, so that there will be no difficulty in referring to the originals.]

Plate A.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Sivatherium giganteum*. Cranium of female, with perfect series of six molars on either side. The specimen is broken off in front of the molar ridges.—B.M. No. 39,523.

From anterior margin of foramen magnum to alveolus of first molar, 16· in. From anterior to posterior side of last molar, 8·25 in. Width of skull between borders of auditory foramina, 9·3 in. From the anterior margin of auditory foramen to the rear molar, 6·9 in. Extreme length of fragment, 19·7 in. Height of occiput, 6·5 in. Breadth of occiput, 9·5 in. Length of molar series, 8·5 in. Length of true molar series along alveolar border, 4·11 in. Length of premolar series along alveolar border, 4·4 in. Between anterior premolars, 2·4 in. Between posterior molars, 4·3 in. Length of palate in mesial line from anterior edge of first premolar to palatine notch, 6·10 in. Length from lower border of foramen magnum to palatine notch, 9·5 in. Probable width across external orbital angles, 12· in. Length of orbit, 3·2 in. Length between auditory process and posterior border of orbit, 6·5 in. Probable height at posterior border of palate in mesial line, 6·5 in.

Figs. 2 and 2 *a*.—Portion of cranium of *Sivatherium giganteum*, found by Col. Colvin in the lower hills below and west of Nahun. The specimen is valuable, though it has no teeth, from having the occiput very entire, and from its proving the accuracy of Dr. Falconer's assumptions, made before the specimen was found, and based on examination of the original head (Plate XCI.), that the animal had four horns with bony cores, as this has the offset of one of the back branched horns very clearly marked, and suitable to which a large flat horn was found in Capt. Cautley's collection, fig. 4. The parts appear slightly distorted from the occurrence of a shift. This specimen is figured and described by Col. Colvin in the Jour. As. Soc., Feb. 1837, vol. vi. p. 152. It is also figured in Royle's 'Illustrations of the Botany of the Himalayah Mountains,' vol. ii., Plate VI. fig. 1 *c*.

This specimen was presented by Col. Colvin to the Museum of the University of Edinburgh, where it now is. Its dimensions are as follows:—

Length from occipital crest to anterior margin of base of anterior horn-core (on right side), 14·2 in. Between extreme points of occipital crest (imperfect), 16·2

in. Between extreme points of occipital condyles (external angles), 6·1 in. From the basilar surface, between the occipital condyles to occipital crest, 7·5 in. Height of occipital foramen, 1·9 in. Breadth of occipital foramen, 1·8 in. Greatest breadth of upper surface of occipital condyle, 2· in. From occipital crest to posterior border of posterior core, 1·2 in. Breadth of cranium beneath posterior core (distance between outer margins of roots of posterior cores), 12·1 in. Extreme distance between fractured extremities of posterior cores, 21·5 in. Transverse diameter of posterior core before its expansion, 5·8 in. Transverse diameter of root of posterior core, 8·4 in. Thickness of core before expansion, 3·1 in. Great diameter (transverse) of posterior branch, 2·5 in. Thickness (vertical diameter) of posterior branch, 1·6 in. Chord of arc between the origin of posterior branch and occipital crest, 3·1 in. Thickness of stem (thickest part) of core, 3·6 in. Circumference of core before expanding, 15·8 in. Antero-posterior diameter of broken end of anterior core, 4·1 in. Greatest transverse diameter of broken end of anterior core, 3·2 in. Diameter of base of anterior core, 4·9 in. Breadth of cranium beneath anterior cores (at foramen orbitale lacerum), 5·3 in. Between inner margins of articular surfaces of occipital condyles superiorly, 1·7 in. Height of fossa for insertion of ligam. nuchæ, 3·8 in. Base of fossa for insertion of ditto, 6·4 in. Groove between condyles, inferiorly, ·45 in. Between outer margin of condyles (inferiorly) immediately behind parieto-occipital crest, 2·7 in. From grooves behind occipital condyles, inferiorly, to floor of fossa for ligam. nuchæ, 3·7 in.

This is the specimen referred to by Dr. Falconer at page 266, and also figured in Plate XXI. fig. 2.

Fig. 3.—*Sivatherium giganteum.* Fragment of cranium, showing forehead, orbits, and cores of anterior horns. This is the same specimen as figured in Plate XCII. figs. 2 and 2 *a*.—B.M.

Antero-posterior diameter of orbit, 4· in. Height of orbit, 2·7 in. Width of malar bone, 2·7 in. Width between anterior angles of orbit, 11·2 in. Width between outer margins of orbital cornua, 12· in. Long diameter of fractured end of right horn, 5·18 in. Short or transverse diameter of right horn, 3·10 in. Probable width between mastoid processes, 16· in.

Fig. 4.—*Sivatherium giganteum.* Fragment from middle of posterior horn. This specimen was in Sir Proby Cautley's collection, and was found to correspond to the posterior horn-core in Col. Colwin's specimen. It is also figured in Plate XXI. fig. 3, *antea*, p. 268.—B.M. No. 39,525.

Length following curvature, 21· in. Circumference at lower attachment, 18· in. Breadth at offset, 8·1 in. Length of offset at base, 5· in. Width of offset at base, 4·6 in. Breadth at fractured upper extremity, 6·8 in. Greatest thickness at upper extremity, 2·3 in.

Fig. 5.—*Sivatherium giganteum.* Fragment from apex of posterior flattened horn.—B.M. No. 39,524.

Extreme length, 10·6 in. Breadth at base, 8·4 in. Thickness (extreme), 1·8 in.

Plate B.

Sivatherium giganteum.—Figs. 1, 1 *a*, and 1 *b*.—Fragment of atlas, comprising lower arch.—B.M. No. 39,526.

Extreme length of fragment, 8·3 in. Antero-posterior diameter of lower arch, 3·1 in.

Fig. 2.—Atlas, very perfect.—B.M. No. 39,527.

Extreme breadth, 8·3 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Axis.—B.M. No. 39,528.

Extreme length, including odontoid process, 7·6 in. Extreme breadth of anterior articular surface, 5·7 in. Length of spinal platform, 5·2 in. Height of spinal canal, posteriorly, 1·7 in. Breadth of spinal canal, posteriorly, 1·7 in.

Figs. 4 and 4 *a*.—Second, third, fourth, fifth, sixth, and seventh cervical vertebræ *in situ*.

Length of conjoined vertebræ, 27·4 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Sixth cervical vertebræ.—B.M. No. 16,225.

Extreme length of body, 5·8 in. Height of spinal canal, posteriorly, 1·3 in. Width of spinal canal, ditto, 1·6 in.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Cervical vertebra.—B.M. No. 18,173.

Extreme length of body, 6·1 in. Between outer margins of anterior articular processes, 7·6 in.

Figs. 7, 7 *a*, 7 *b*, and 7 *c*.—Seventh cervical vertebra.—B.M. No. 15,707.

Extreme length of body, 5·1 in. Width of spinal canal, 2·5 in.

Figs. 8, 8 *a*, and 8 *b*.—First dorsal vertebra. It resembles that of the British elk.

Extreme length of body, 4·5 in. Width across transverse processes, 8·1 in.

Figs. 9, 9 *a*, and 9 *b*.—Dorsal vertebra.—B.M. No. 17,078.

Extreme length of body, 4·7 in. Extreme width across transverse processes, 7· in.

Fig. 10.—Four dorsal vertebræ *in situ*.

Length of conjoined vertebræ, 13·8 in.

Figs. 11 and 11 *a*.—Lower end of tibia, with bones of tarsus. *a*. tibia; *b*. fibular element; *c*. astragalus; *d*. calcaneum; *e*. cuboid; *f*. scaphoid.—B.M. No. 39,529.

Length of fibular element, 2·6 in. Height of fibular element (*a*), 1·3 in. Length of fragment of os calcis (lower edge), 5· in. Height of fragment to fibular surface, 3·3 in. Width of trochlea of astragalus (*c*), 3·1 in. Length of astragalus internally, 4·2 in. Length of scapho-cuboid (inferiorly), 2·1 in. Length of ento-cuneiform (superiorly), 1·1 in.

Figs. 12, 12 *a*, and 12 *b*.—Phalanx (first?) of posterior extremity.—B.M. No. 39,530.

Extreme length, 5·1 in. Width of upper articular surface, 2·5 in. Width of lower articular surface, 2·2 in.

Figs. 13, 13 *a*, 13 *b*, and 13 *c*.—Phalanx (second?) of posterior extremity.—B.M. No. 15,805.

Extreme length, 2·6 in. Width of upper articular surface, 2·2 in. Width of lower articular surface, in centre, 2· in.

Plate C.

Sivatherium giganteum. Bones of anterior extremity.

Figs. 1 and 1 *a*.—Fragment of sternum.—B.M.

Length of fragment, 14·8 in. Greatest depth, 5·5 in. Greatest width, inferior end, 4·2 in. Greatest width, upper end, 3·3 in.

This specimen is also figured in Plate XXI. fig. 5. (See *antea*, p. 270.)

Figs. 2 and 2 *a*.—Fragment of scapula, showing glenoid cavity and coracoid process.—B.M. No. 36,680.

Length of fragment, 11·8 in. Great diameter of glenoid cavity, 4·4 in. Lesser diameter of glenoid cavity, 3·3 in. Elevation of coracoid process above glenoid cavity, 1·8 in. Breadth of scapula towards neck, 4·4 in.

Figs. 3 and 3 *a*.—Glenoid cavity, and coracoid process of scapula.—B.M. No. 39,531.

Length of fragment, 6· in. Great diameter of glenoid cavity, 4·8 in. Lesser diameter of glenoid cavity, 4· in. Elevation of coracoid process above glenoid cavity, 1·8 in.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—Humerus entire. The dimensions almost (not quite) agree with B.M. No. 39,688.

Length of humerus, 20·2 in. Breadth of upper extremity, 8·4 in. Greatest ant.-posterior diam. of upper extremity, 7·7 in. Great diameter of articular surface of head, 5·5 in. Lesser diameter of articular surface of head, 5·2 in. Breadth of inferior extremity, 7·2 in. Antero-posterior diameter, internally, 5·5 in. Breadth of inferior articular surface, 6·2 in. Smallest antero-posterior diameter of inferior articular surface, 2·2 in. Smallest transverse diameter of shaft, 3·8 in. Smallest antero-posterior diameter of shaft, 3·3 in.

Figs. 5, 5 *a*, and 5 *b*.—Upper half of humerus with double bicipital groove.—B.M. No. 39,532.

Length of fragment, 10· in. Transverse diameter of upper extremity, 6·3 in. Antero-posterior diameter greatest of ditto, 7·8 in. Greatest diameter of articular surface of head, 5· in. Lesser diameter of articular surface of head, 4·6 in. Circumference at broken extremity, 11· in.

Figs. 6, 6 *a*, 6 *b*, and 6 *c*.—Radius and ulna conjoined; entire length. —B.M. No. 39,534.

Length of united radius and ulna, 30·2 in. Length of radius, 25·8 in. Width of radius above articular surface, 7·4 in. Chord of sigmoid cavity, 3·1 in. From anterior edge of sigmoid cavity to posterior border of olecranon, 10·8 in. Depth of olecranon, 5·5 in. Breadth of inferior extremity, 6·1 in. Breadth of inferior articular surface, 5·5 in. Greatest antero-posterior diameter of ditto, 3·6 in. Transverse diameter of centre of shaft, 4·5 in. Antero-posterior diameter of centre of ditto, 2·5 in.

Fig. 7.—Upper articular surface of conjoined radius and ulna.—B.M. No. 39,535.

Length of radius, 10·8 in. Width of articular surface above, 7·2 in. Width of upper extremity, 8·3 in. Greatest antero-posterior diameter of articular surface, 3·6 in.

Figs. 8 and 8 *a*.—Lower end of conjoined radius and ulna, with bones of carpus and upper end of metacarpal bone.

Transverse diameter of scaphoid (1), 1·9 in.; height of ditto, 1·6 in. Transverse diameter of semilunar (2), 2·1 in.; height of ditto, 1·8 in. Transverse diameter of cuneiform (3), 1·4 in.; height of ditto, 1·8 in. Transverse diameter of united trapezium, trapezoid, and os magnum (5), 2·3 in.; height of ditto, 1·4 in. Transverse diameter of unciform (6), 1·9 in.; height of ditto, 1·4 in. Breadth of inferior extremity of radius and ulna conjoined, 5·3 in. Breadth of upper extremity of metacarpal bone, 4·5 in.

Fig. 9.—Carpal bones, viz., scaphoid (1), semi-lunar, cuneiform (3), os magnum (5), and unciform (6).

Height of scaphoid, 2·1 in.; breadth of ditto, 1·7 in. Height of semilunar, 2·4 in.; breadth of ditto, 2·3 in. Height of cuneiform, 2·6 in.; breadth of ditto, 2·4 in. Height of os magnum, 1·7 in.; breadth of ditto, 3·1 in. Height of os unciforme, 2· in.; breadth of ditto, 2·1 in. Antero-posterior diameter of os magnum, 3·5 in. Antero-posterior diameter of os unciforme, 2·9 in.

Figs. 10 and 12.—First row of carpal bones, viz., scaphoid (1), semilunar (2), and cuneiform (3).

Antero-posterior of scaphoid, 3·4 in. Antero-posterior of semilunar, 2·2 in. Antero-posterior of cuneiform, 2·5 in.

Figs. 11 and 13.—Second row of carpal bones, viz., os magnum (5) and unciform (6).

Fig. 14.—Phalanges of anterior extremity, restored.

Figs. 15, 15 *a*, 15 *b*, and 15 *c*.—Right metacarpal bone.—B.M. No. 39,533.

Length of right metacarpal, 13·7 in. Breadth of superior articular surface, 4·7 in. Greatest antero-posterior of ditto, 2·7 in. Breadth of inferior articular surface, 4·7 in. Breadth of a single trochlea, 2·2 in. Antero-posterior diameter of a single trochlea measured along ridge, 2·4 in.

Figs. 16, 16 *a*, 16 *b*, and 16 *c*.—First phalanx.—B.M. No. 39,541.

Length between articular surfaces, 4·6 in. Transverse diameter of posterior articular surface, 2·3 in. Height of posterior articular surface in centre, 1·6 in. Transverse diameter of anterior articular surface, 2·3 in. Height of anterior articular surface in centre, 1·4 in.

Figs. 17, 17 *a*, 17 *b*, and 17 *c*.—Second phalanx—B.M. No. 39,542.

Length, 2·4 in. Transverse diameter of posterior articular surface, 2·4 in. Height of posterior articular surface measured along ridge, 1·5 in. Transverse diameter of anterior articular surface, 2·5 in. Height of anterior articular surface, 2·5 in.

Figs. 18, 18 *a*, and 18 *b*.—Hoof-bone.

Length, 5·2 in. Height, 2·5 in. Breadth, 2·3 in. Length of articular surface, 1·9 in. Breadth of articular surface, 1·9 in.

Plate D.

Bones of posterior extremity of *Sivatherium giganteum*.

Figs. 1, 1 *a*, and 1 *b*.—Fragment of upper end of femur, with articular surface.—B.M. No. 39,545.

Length of fragment, 7·4 in. Breadth of upper extremity including the trochanter, 7·5 in. Antero-posterior diameter of greater trochanter, 3·6 in. Antero-posterior diameter of articular surface of head, 3· in. Transverse diameter of articular surface of head, 3·8 in.

Figs. 2, 2 *a*, and 2 *b*.—Fragment of upper end of femur with articular surface.

Length of fragment, 8·4 in. Antero-posterior diameter of great trochanter, 4· in.

Figs. 3, 3 *a*, and 3 *b*.—Lower end of femur, with condyles and articular surface.—B.M. No. 39,546.

Length of fragment, 9·6 in. Breadth of inferior extremity, 6·4 in. Antero-posterior diameter internally, 8·6 in. Antero-posterior diameter externally, 6· in. Height of rotular surface in centre, 4·1 in. Breadth of rotular surface in centre, 2·9 in.

Figs. 4, 4 *a*, and 4 *b*.—Fragment of lower end of femur, showing articular surface.—B.M. No. 39,547.

Breadth of inferior extremity, 7·6 in. Height of rotular surface in centre, 4·7 in.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Entire tibia.—B.M. No. 17,072.

Extreme length of tibia, 20·3 in. Breadth of upper extremity, 6· in. Antero-posterior diameter of upper extremity, 3·5 in. Breadth of inferior extremity, 4·6 in. Antero-posterior diameter of ditto, 3·2 in. Breadth of shaft (smallest), 2·7 in. Antero-posterior diameter of shaft (ditto), 1·9 in.

Figs. 6, 6 *a*, and 6 *b*.—Proximal end of tibia, with articular surface. —B.M. No. 18,452.

Length of fragment, 9·5 in. Breadth of upper extremity, 6·8 in. Antero-posterior diameter of ditto, 3·8 in.

Figs. 7, 7 *a*, and 7 *b*.—Proximal end of tibia, with articular surface. —B.M. No. 16,611.

Breadth of upper extremity, 7·1 in. Antero-posterior diameter of ditto, 4· in.

Figs. 8, 8 *a*, and 8 *b*.—Distal half of tibia, with lower articular surface.—B.M. No. 39,548.

Length of fragment, 9·5 in. Breadth of inferior extremity, 5· in. Antero-posterior diameter of ditto, 3· in.

Figs. 9, 9 *a*, and 9 *b*.—Distal end of tibia, with lower articular surface.—B.M. No. 39,549.

Length of fragment, 7· in. Breadth of inferior extremity, 5· in. Antero-posterior diameter of ditto, 2·6 in.

Fig. 10.—Calcaneum and astragalus, *in situ*, restored.

Figs. 11, 11 *a*, and 11 *b*.—Astragalus.—B.M. No. 16,998.

Length of astragalus, extreme, 4·9 in. Breadth of ditto, 3·4 in. Height of ditto, 2·4 in.

Figs. 12, 12 *a*, and 12 *b*.—Calcaneum, imperfect.—B.M. No. 39,543.

Length of fragment, 8·2 in. Projection of heel, 6·2 in. Breadth of calcaneal tuberosity, 2·9 in. Height of calcaneal tuberosity, 2·8 in.

Figs. 13, 13 *a*, 13 *b*, 13 *c*, and 13 *d*.—Scapho-cuboid bone.—B.M. No. 39,544.

Breadth of scapho-cuboid bone, 4·9 in. Greatest antero-posterior diameter, 5· in. Greatest height, 3·4 in. Breadth of astragalar surface, 3·6 in. Breadth of calcaneal ditto, 1·3 in. Breadth of cuneiform ditto, 1·5 in. Breadth of metatarsal ditto, 1·8 in.

Plate E.

Camelopardalis Sivalensis (Falc. and Caut.).

Figs. 1, 1 *a*, 1 *b*, 1 *c*, and 1 *d*.—Third cervical vertebra of fossil giraffe, from the Sewalik hills. The elongated character of the vertebra shows that the animal had a columnar neck, and the fact that the transverse processes are provided with foramina for the vertebral arteries shows that it was not a camel. The complete synostosis of the upper and lower articulating surfaces, the strong relief of the ridges, and the depth of the muscular depressions, indicate that the animal was an adult, which had long attained its full size.

A note of this specimen, by Captain (now Sir Proby T.) Cautley, appeared in the Journ. As. Soc. for July 1838, vol vii. p. 658, and a detailed account was afterwards communicated to the Geological Society of London by Dr. Falconer and Captain Cautley, an abstract of which appeared in the 'Proceedings,' No. 98. In the latter communication the measurements and drawings of the specimen are given (See *antea*, p. 197, and Pl. XVI. figs. 1, 2, 3, and 4).—B.M. No. 39,747.

Figs. 2 and 2 *a*.—Fragment of second cervical vertebra of *Camelopardalis Sivalensis*, from Perim Island. The right margin of the drawing shows the mesial longitudinal ridge under the side of the body, and the left margin is the ridge of the spinous process. The process pointing

downwards on the left side is the inferior oblique process. The cup-shaped articulating surface for the head of the third cervical vertebra is well seen.

This specimen was in the collection of fossils brought from Perim Island by Captain Fulljames, and was described and figured by Dr. Falconer in the Quarterly Journal of the Geol. Soc., vol. i. Plate XIV. fig. 5 (See *antea*, p. 398).—B.M. No. 39,748.

Length of fragment, 4·9 in. Height of body posteriorly, 2·5 in. Greatest breadth posteriorly between remains of transverse processes, 3·1 in. Height of the spinal canal, 1·4 in. Height of the broken surface of the spine above inferior margin of body, 5·4 in. Vertical diameter of articulating cup, 2·1 in. Transverse diameter of ditto, 2·1 in.

Figs. 3 and 3 *a*.—R. humerus, head wanting.—B.M. No. 39,749.

Length of humerus wanting upper head, 17·7 in. Breadth of inferior extremity, 5·2 in. Antero-posterior diameter of inferior extremity, 4·3 in. Breadth of articular surface of inferior extremity, 4·8 in. Breadth of upper extremity, 4·1 in. Circumference at smallest part of shaft, 7·9 in.

Figs. 4, 4 *a*, and 4 *b*.—Fragment of shaft of left radius and ulna.—B.M. No. 17,130.

Length of fragment, 8·5 in. Greatest diameter, 3· in. Smaller ditto, 2·1 in. Great diameter of ulna at upper extremity, ·7 in. Thickness of ditto, ·5 in.

Figs. 5, 5 *a*, and 5 *b*.—Radius and ulna, restored.

Figs. 6, 6 *a*, and 6 *b*.—Metacarpal bone, fragment including upper end.—B.M. No. 39,750.

Length of fragment, 18·7 in. Transverse diameter of upper extremity, 3·7 in. Antero-posterior diameter of upper extremity, 2·3 in. Transverse diameter of centre of shaft, 2·4 in. Antero-posterior diameter of ditto, 1·8 in.

Figs. 7 and 7 *a*.—Fragment of shaft of metacarpal bone.—B.M. No. 39,751.

Length of fragment, 6·8 in. Transverse diameter of shaft, 2·3 in. Antero-posterior diameter of ditto, 1·3 in.

Figs. 8 and 8 *a*.—Fragment of shaft of metacarpal bone.—B.M. No. 17,129.

Length of fragment, 4·2 in. Transverse diameter of shaft, 2· in. Antero-posterior diameter of ditto, 2· in.

Figs. 9 and 9 *a*.—Fragment of shaft of metacarpal bone, near lower end.—B.M. No. 17,131.

Length of fragment, 3·9 in. Transverse diameter of shaft at lower extremity, 2·8 in. Antero-posterior ditto at upper ditto, 1·5 in.

Figs. 10, 10 *a*, and 10 *b*.—Entire metacarpal bone, restored.

Figs. 11, 11 *a*, and 11 *b*.—First cervical vertebra, imperfect.—B.M. No. 39,746.

Length of fragment, 4·2 in. Height of body posteriorly, 3·3 in.; breadth of ditto, 2·8 in. Between extremities of transverse processes, 6· in. Between inner angles of posterior articular processes, 2· in. Length of posterior articular surface, 2·1 in.; breadth of ditto, 1·2 in. Height of spine above inferior margin of body, 6·4 in. Height of spinal canal, 1·4 in.; breadth of ditto, 1·6 in.

Figs. 12, 12 *a*, 12.*b*, and 12 *c*.—Left metatarsal bone of *Sivatherium giganteum*.—B.M. No. 39,752.

Length of left metatarsal, 16·4 in. Transverse diameter of upper extremity, 3·8 in. Antero-posterior diameter of ditto, 3·3 in. Transverse diameter of lower

extremity, 4· in. Transverse diameter of a single trochlea, 1·9 in. Antero-posterior diameter measured alongst ridge of trochlea, 2·2 in. Transverse diameter of shaft, 2·1 in. Antero-posterior ditto, 2·1 in.

Figs. 13, 13 *a*, and 13 *b*.—Fragment of upper end of metatarsal bone of *Sivatherium giganteum*.—B.M. No. 39,753.

Length of fragment, 7·2 in. Transverse diameter of upper extremity, 4·1 in. Antero-posterior diameter of ditto, 3·8 in.

Plate F.

Bramatherium Perimense (Falc.), from Perim Island. A large and peculiar ruminant, nearly equalling the Sivatherium in size, but essentially different. The plate represents fragments of the bones of the anterior and posterior extremities. A description of two fragments of the left upper jaw, including the entire series of upper grinders, will be found in the memoir on Perim Island fossils. (See *antea*, p. 399). The specimens figured in this plate were brought from Perim Island by Captain Fulljames.

Figs. 1, 1 *a*, and 1 *b*.—Fragment of lower end of humerus, with articular surface.

Figs. 2 and 2 *a*.—Fragment of upper end of ulna, with olecranon and sigmoid cavity.

Figs. 3, 3 *a*, and 3 *b*.—Fragment of lower end of radius and ulna.

Figs. 4, 4 *a*, and 4 *b*.—Fragment of lower end of radius and ulna.

Figs. 5 and 5 *a*.—Fragment comprising portion of shaft and distal extremity of metacarpal bone.

Figs. 6 and 6 *a*.—Fragment comprising distal articulating extremity of metacarpal bone.

Figs. 7, 7 *a*, and 7 *b*.—Fragment of upper end of femur.

Figs. 8, 8 *a*, 8 *b*, 8 *c*, and 8 *d*.—Calcaneum.

Figs. 9, 9 *a*, 9 *b*, 9 *c*, and 9 *d*.—Astragalus.

Figs. 10, 10 *a*, 10 *b*, 10 *c*, 10 *d*, and 10 *e*.—Astragalus.

Plate G.

Bos Namadicus (Falc. and Caut.), from the Nerbudda.

Figs. 1, 1 *a*, and 1 *b*.—Fragment of cranium, showing forehead, occiput, occipital condyles, and foramen magnum; portion of right horn and core of left horn. The specimen shows well the flat square forehead, the height being about equal to the breadth. The horns are attached to the extremity of the highest salient line of the head. The horn-cores spread out horizontally, with a slight arch upwards and concavity below. The section of the horn-core shown in fig. 1 *b*. is much more circular than in the Gour or Gayal or than in *Bos Palæindicus*.

This specimen, which is in the British Museum (No. 39,760), is also figured in Plate XXII. (See also *antea*, p. 286.)

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—*Bos Namadicus*. Four different views of

cranium, including orbit, nasal bones, and palate, and four posterior molars on either side. The forehead is mutilated and the horn-cores are broken off.—B.M. No. 39,758.

Bos Palæindicus (Falc. and Caut.), from the Nerbudda.

Figs. 3 and 3 *a*.—Fragment of cranium, including orbits, horn-cores, frontal and occipital, on both sides (See *antea*, p. 284).—B.M. No. 39,716.

Fig. 4.—Fragment of cranium, showing occiput, foramen magnum, condyles, and horn-cores.—B.M. No. 39,717.

Figs. 5 and 5 *a*.—Fine specimen of cranium, showing occiput, condyles, and foramen magnum, portion of right horn and left horn-core, both orbits, palate, and four posterior molars. The upper surface of the frontal is arched. The horn-cores spread out more horizontally, and with a less inclination upwards than in the existing wild buffalo, and are slightly concave anteriorly and convex behind. In these respects it differs from the existing wild buffalo, and so far as the horizontal offset is concerned, it approximates to the Gayal, from which, however, it differs in the flattened form of the horns and in every other respect. These characters are so constant that there can be little doubt that the species is distinct from the existing wild buffalo.—B.M. No. 39,759.

Fig. 6.—Fragment showing anterior portion of upper jaw, with intermaxillary bones.—B.M. No. 39,715.

Figs. 7 and 7 *a*.—Fragment of horn, broken off at tip, and of a compressed form. Fig. 7 *a* shows the flattened form of the horn, as seen at section. This, as well as the fragment represented in fig. 6, have been found to belong to a skull in the British Museum (No. 39,715), to which they are now attached. This skull is also represented in Plate XXII. (See also *postea*, p. 354.)

Length, 33·5 in. Greatest diameter, 6·5 in. Least ditto, 3·25 in.

Plate H.

Hemibos triquitriceras. (Falc. and Caut.), from the Sewalik hills.

Figs. 1 and 1 *a*.—Cranium, including both orbits and horn-cores, occiput, nasals, palate, and entire molar series on both sides.—B.M. No. 39,584.

Length of fragment, 18·2 in. Great diameter of core, 4· in. Breadth of cranium at post. angles of orbits, 8·7 in. Great diameter of orbit, 2·7 in. Length of molar series, 5·4 in. Length of three premolars, 2 3 in. Width of palate anteriorly and posteriorly, 2·9 in. Height of cranium from middle of palate, 4·2 in. Breadth of ditto in front of premolars, 4· in.

Figs. 2 and 2 *a*.—Another fine specimen of cranium, showing occipital condyles and foramen, palate and five back molars on either side, both horn-cores, and a portion of right horn. The remarkable triangular form of the horn-core is well shown.—B.M. No. 16,411.

Length of fragment, 14·4 in. Height of occipital facet from lower border of occipital foramen to summit of occipital crest, 4·8 in. Between extreme points of occipital crest, 8·8 in. Breadth of cranium beneath cores, 4·6 in. Breadth of cranium at post. angles of orbits, 8·8 in. Length of core from roughness on frontal bone, 11·3 in. Base of the triangular core ant. surface (at origin), 3·9 in. Base of the triangular core ant. surface (at broken end), 3· in. Diameter of occipital

condyle, 2·6 in. Height of occipital foramen, 1·5 in. Breadth of ditto, 1·2 in. Greatest diameter of orbits, 2·5 in. From lower border of occipital foramen to posterior border of palate, 6·2 in. Length of true molar series, 3·2 in. Length of two posterior premolars, 1·3 in. Width of palate posteriorly and anteriorly, 2·8 in. Width of alveoli, 1·3 in.

Figs. 3 and 3 *a*.—Fine specimen of cranium, showing orbits and horn-cores, but no horns, nasals, palate with entire molar series (on left side), nasal and intermaxillary bones almost complete. Presented by Colonel Colvin.—B.M. No. 23,109.

Length of fragment, 17· in. Breadth of cranium between posterior angles of orbit, 8·8 in. Between most projecting points of maxillary bones, 5·7 in. Breadth at intermaxillaries, 3·5 in. Breadth of two nasal bones, 1·9 in. Length of molar series, 5·3 in. Length of three true molars, 3·3 in. Breadth of alveoli, 1·2 in. Width of palate, 3·1 in.

Figs. 4, 4 *a*, and 4 *b*.—Very perfect specimen of cranium, showing horn-cores, orbits, occipital foramen and condyles, palate, and entire molar series on either side. Probably a female.—B.M. No. 16,173.

Length of fragment, 13·7 in. Height of occipital facet from lower border of occipital foramen to occipital crest, 3·8 in. Breadth of cranium beneath cores, 3·8 in. Breadth of ditto at posterior angles of orbits, 7·6 in. Height of occipital foramen, 1·4 in. Breadth of ditto, 1·2 in. Diameter of occipital condyle, 2· in. From lower border of occipital foramen to posterior border of palate, 5·9 in. Length of three true molars, 3·2 in. Length of two posterior premolars, 1·4 in. Width of palate, 3· in. Breadth of alveoli, 1·2 in. Great diameter of orbits, 2·8 in. Lesser diameter of ditto, 2·5 in. Diameter of core at root, 2·3 in.

Plate I.

Bos (*Amphibos*) *acuticornis* (Falc. and Caut.), from the Sewalik hills.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Fine specimen of cranium, showing palate and molar series, occiput, orbits, and horn-cores, but without horns.

Figs. 2 and 2 *a*.—Fragment of cranium with both horns, perfect to the tips. The direction of the horns is more upright and less horizontal than in *Hemibos triquitriceras*. The horns are rounded on their anterior surface and flattened behind, and taper to a point.—B.M. No. 39,560.

Between mastoid angles, 8·5 in. Height of occipital facet from lower border of occipital foramen, 4·4 in. Between external angles of condyles, 4·3 in. Diameter of condyle, 2·2 in. Height of occipital foramen, 1·4 in. Breadth of occipital foramen, 1·3 in. Breadth of cranium beneath the cores, 4·5 in. Breadth of cranium in front of the cores, 7·5 in. Length of cores along great curvature, 27· in. Between tips of cores, 33·6 in. Antero-posterior diameter of core (inner surface), 3·4 in. Circumference of core at root, 12· in. Between nearest points of base of cores, 2·8 in.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Another specimen of cranium, with palate and entire series of six molars, occiput, both orbits, and horn-cores.—B.M. No. 39,564.

Length of fragment, 17·4 in. From posterior plane of occipital condyles to anterior margin of molar series, 13·7 in. Length of molar series, 5·4 in. Length of three true molar teeth, 3·3 in. Breadth of alveoli, 1·1 in. Width of palate posteriorly; 2·8 in. Between external angles of occipital condyles, 4·5 in. Height of occipital facet from lower border of foramen magnum, 4·3 in. Height of occipital foramen, 1·4 in. Between mastoid angles, 7·2 in. Width of cranium beneath cores, 3·7 in. Between most projecting points of maxillary bones, 5·8 in. Breadth opposite sub-orbital foramina, 4·1 in. Least width of nasal bones, 1·4 in. Great diameter of orbit, 2·8 in.

Plate K.

Felis cristata (Falc. and Caut.), from the Sewalik hills. This fossil Tiger forms the subject of a special memoir (See *antea*, page 315).

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Four different views of an imperfect specimen of the cranium, from Mr. W. Ewer's collection. The left maxillary bone with the teeth is absent, but this portion was found after the drawing was made, and has been added to the specimen in the British Museum (No. 15,902). The specimen shows well the great prominence of the sagittal crest, whence the specific name is derived, also the relative shortness of the facial portion of the head, the great height of the occipital, and the horizontal outline of upper surface of cranium.

Figs. 2, 2 *a*, 2 *b*, and 2 *c*.—Another specimen of the cranium with the alveolar ridges almost perfect. The anterior portion of the palate with the incisors is broken off. The canine, two false molars, the carnassier, and tuberculous teeth well seen. This is the specimen which is also figured in Plate XXV. figs. 1 to 4.—B.M. No. 37,133.

Figs. 3, 3 *a*, and 3 *b*.—Mutilated fragment of posterior portion of cranium.—B.M. No. 37,134.

Figs. 4, 4 *a*, and 4 *b*.—Mutilated fragment of anterior portion of cranium and face, showing the left orbit entire, the palate, and the series of teeth on both sides.—B.M. No. 37,135.

Plate L.

Hyæna Sivalensis (Falc. and Caut.)—Fossil Hyæna from the Sewalik hills. Unfortunately no description of this fossil was ever published, and no account of it is to be found among Dr. Falconer's notes. This species, however, is no doubt that designated *Hyæna Sivalensis* by Messrs. Baker and Durand in the brief description given by them in the Journal of the Asiatic Society for October 1835, vol. iv. p. 569. Their description is accompanied by drawings of a remarkably perfect specimen of the skull, with the lower jaw *in situ*.

Figs. 1 and 1 *a*.—Fragment of anterior portion of right side of palate, with canine, and incisor teeth.—B.M. No. 39,718.

Figs. 2, 2 *a*, and 2 *b*—Fragment of anterior portion of cranium, showing canine and incisors in very perfect state.—B.M. No. 16,583.

Figs. 3, 3 *a*, and 3 *b*.—Another fragment of anterior portion of palate with three incisors.—B.M. No. 39,719.

Fig. 4.—Dental series, right side, consisting of canine anteriorly, three false molars, the two posterior of which are very large. A very large carnivorous tooth with a small tubercle within and in front, and a small back or fifth molar, placed transversely at the back of the palate.

Figs. 5 and 5 *a*.—Fragment of upper jaw, left side, containing hindmost false (or third) molar, large carnivorous tooth or fourth molar, and small back or fifth molar, placed transversely at the back of the palate.—B.M. No. 34,140.

Figs. 6 and 6 *a*.—Fragment of upper jaw, right side, containing three false molars, large carnivorous tooth with its internal tubercle, and a portion of the fifth or small back molar.—B.M. No. 37,137.

Figs. 7 and 7 *a*.—Fragment of upper jaw, right side, with hindmost false or third molar, and large carnivorous tooth with its internal tubercle.—B.M. No. 37,139.

Figs. 8 and 8 *a*.—Fragment of upper jaw, right side, with two posterior false molars, and large carnivorous tooth with internal tubercle.—B.M. No. 37,138.

Figs. 9 and 9 *a*.—Large carnivorous tooth with internal tubercle detached.—B.M. No. 15,413.

Fig. 10.—Dental series of *Hyæna*, left side, comprising canine, three false molars (two back ones large), large carnivorous tooth with internal tubercle in front, and small back molar placed transversely at back of palate.

Plate M.

Figs. 1 and 1 *a*.—*Hyæna Sivalensis*. Fragment of lower jaw, right side, very perfect, containing carnivorous molar and two backmost false molars.—B.M. No. 16,565.

Figs. 2 and 2 *a*.—*Hyæna Sivalensis*? Fragment of lower jaw, left side, containing three incisors, one canine, three false molars, and one large carnivorous molar. Belongs to an undetermined feline animal (Hyæna?).—B.M. No. 16,555.

Figs. 3 and 3 *a*.—*Hyæna Sivalensis*. Fragment of lower jaw, left side, with canine and three false molars.—B.M. No. 16,584.

Figs. 4 and 4 *a*.—*Hyæna Sivalensis*. Imperfect fragment, lower jaw, right side, with two incisors, canine, and three false molars.

Figs. 5 and 5 *a*—*Hyæna Sivalensis*. Imperfect fragment, lower jaw, left side, containing canine, three false molars, and large carnivorous molar. Large mental foramen corresponding to front false molar.—B.M. No. 39,731.

Figs. 6 and 6 *a*.—*Hyæna Sivalensis*? Fragment of anterior portion, lower jaw, right side, containing two incisors, canine, and two anterior false molars. (An. *Felis*?)—B.M. No. 16,585.

Figs. 7 and 7 *a*.—*Hyæna Sivalensis*? Crushed fragment, lower jaw, left side, containing carnivorous molar and two back false molars. (An. *Felis*?)—B.M. No. 37,140.

Figs. 8 and 8 *a*.—*Hyæna Sivalensis*? Fragment of lower jaw, right side, containing two posterior false molars, and large bicuspid carnivorous false molar.—B.M. No. 16,578.

Fig. 9.—*Hyæna Sivalensis*. Fragment of lower jaw, right side, containing three false molars and large canine. Large mentary foramen corresponding to front false molar.

Plate N.

Drepanodon (*Machairodus*) *Sivalensis* (Falc. and Caut.), or fossil Drepanodon, from the Sewalik hills. No description of this fossil was ever published, but the Sewalik specimens are referred to by Professor Owen in 'British Fossil Mammalia,' pp. 178,179, and also in 'Odontography,' vol. i. p. 491. A brief description of it is also given by Dr. Falconer in his 'Notes on the Fossil *Felis spelæa* of the Mendip Hills.' See vol. ii.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Drepanodon Sivalensis*. Fragment of posterior portion of skull, showing occipital condyles, foramen magnum, and prominent sagittal crest.—B.M. No. 39,278.

Fig. 2.—*Drepanodon Sivalensis*. Mutilated specimen of cranium, including facial portion, but no distinct evidence of teeth.—B.M. No. 39,729.

Figs. 3 and 3 *a*.—*Drepanodon Sivalensis*. Fine fragment of upper jaw, right side, with apparently the first or deciduous dentition. The crown of the canine is broken off, but what remains is seen to be flat, and very finely serrated along the posterior edge, like a shark's tooth. The tooth evidently bore the same proportion to the molar series as does the canine of the *Felis megantereon* of Bravard (*Vide* Owen, Brit. Fos. Mam. p. 178).—B.M. No. 16,350.

The following note, from Dr. Falconer's Note-book, dated October 2, 1858, probably referred to this specimen and to that represented in fig. 5 :—

'In the Sewalik Machairodus the right upper carnassier is formed with a very thin blade. The anterior lobe is damaged, but judging from what remains it would seem to have been two-lobed. The middle lobe is thin and pointed; but neither the anterior lobe nor the middle one bears the slightest indication of an internal tubercle. If ever there, it is gone. Owen describes it as being there, "but less developed than in the normal species of *Felidæ*." The posterior lobe is nearly horizontal and very trenchant; in fact, the tooth is compressed and sharp-edged. All the points rise. The length of the crown is ·75 inch. There is an interval between the carnassier and canine of 0·8 in., part of which has been artificially rubbed down, but there is not the least indication of a fang-pit or fang. (Owen says there is, and that it is single-fanged and simple!) There is a distinct show of a double fang, fore and aft, of a tubercular in a line with the sectorial, behind it. The breadth of the canine at its base is 0·5 in. It is very compressed. The posterior concave edge is finely serrated. (Owen says that both edges are distinctly serrated.)'

This specimen is also figured in Plate XXV. fig. 5.

Figs. 4 and 4 *a*.—*Drepanodon Sivalensis*. Fragment of lower jaw with three premolars, the last being the sectorial. Professor Owen refers to this specimen in the following description :—

'A portion of the lower jaw of a larger Machairodus, from the Sewalik range, shows the beginning of the characteristic downward extension of the symphysis, and the depression on the outside of the ramus for the lodgment of the long upper canine. The molar series, which consists, as in the typical Felines, of three premolars, the last being the sectorial tooth, has a longitudinal extent of two inches; the second molar slightly overlaps the third, which has an antero-posterior extent of eleven lines. This portion of jaw indicates a species of Machairodus as large as the Jaguar; it most probably belongs to an adult of the same species as the one indicated by the instructive portion of the upper jaw.' (Fig. 3). (Owen, Brit. Foss. Mam. p. 179).

This specimen is also figured in Pl. XXV. fig. 6.—B.M. No. 16,557.

Figs. 5 and 5 *a*.—*Drepanodon Sivalensis*. Fragment of upper jaw, containing two anterior molars. The first is simple, singled-fanged and very small. The second is the carnassial or sectorial tooth. Its crown is more compressed, its trenchant margins sharp. See description of fig. 4.—B.M. No. 39,730.

Figs. 6 and 6 *a*.—*Drepanodon Sivalensis*. Lower jaw, right side, more perfect than fig. 4, and containing the incisors as well as the canine and three molars. The downward projection of the symphysis, and the depression for the upper canine, are well seen.—B.M. No. 16,573.

Figs. 7 and 7 *a*.—*Drepanodon Sivalensis*. Another specimen of lower jaw, right side, containing three molars and alveolus of large canine.—B.M. No. 16,537.

Figs. 8 and 8 *a*.—*Drepanodon Sivalensis*. Fragment of lower jaw, with three molars.—B.M. No. 16,554.

Plate O.

Ursus (*Hyænarctos*) *Sivalensis* (Falc. and Caut.), from the Sewalik hills. The fossil Bear of the Sewalik hills forms the subject of a distinct memoir (see *antea*, page 321). Its chief peculiarities are to be found in the teeth, which are constructed more after the type of the higher Carnivora than any other described species of the genus.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—Superb specimen of cranium. The three rear molars are perfect on one side, and but little damaged on the other. Both canines are present, and that of the right side is entire. The alveoli of the two false molars and three incisors on either side are distinct, although the teeth are wanting. The only considerable deficiencies are in the posterior and lower parts of the occiput, both zygomatic arches, and in the lower end of the nasals, where a fissure extends across the face, on both sides towards the orbits. Fig. 1 *a* shows the dental series on right side, of natural size.

This specimen is described in detail in the memoir already referred to, and is also represented in Plate XXVI. figs. 1 and 2.—B.M. No. 39,721.

Figs. 2 and 2 *a*.—*Ursus Sivalensis*. Greater part of the body of the lower jaw, broken off where the canine protrudes, and also deficient in the coronoid and articulating processes. There are indications of six molars, of which the two first premolars and the rear tubercular molar have dropped out. The third premolar is distinctly three-lobed. The antepenultimate or carnassier is chiefly remarkable for its length. The penultimate or first tubercular is broader for its length and less complicated with tubercles than what is general in the genus. Fig. 2 *a* shows the dental series of the natural size.

Further details of this specimen are given in the memoir on Ursus (See *antea*, p. 321).—B.M. No. 39,722.

The specimen is also represented in Plate XXVI. figs. 3 and 4.

Figs. 3, 3 *a*, 3 *b*, 3 *c*, and 3 *d*.—*Ursus Sivalensis*. Second cervical vertebra or axis.—B.M. No. 37,143.

Figs. 4, 4 *a*, and 4 *b*.—*Ursus Sivalensis*. Radius and ulna. Greater portion of shafts and lower articulating extremity. From Messrs. Baker's and Durand's collection.—B.M. Nos. 39,725–6.

Figs. 5, 5 *a*, 5 *b*, 5 *c*, and 5 *d*.—*Ursus Sivalensis*. Specimen of femur, very perfect.—B.M. No. 39,723.

Figs. 6, 6 *a*, 6 *b*, 6 *c*, and 6 *d*.—*Ursus Sivalensis*. Distal end of metacarpal bones.—B.M. No. 37,147.

Figs. 7, 7 *a*, and 7 *b*.—*Ursus Sivalensis*. Fragment of phalanx.

Fig. 8.—*Ursus Namadicus* (Falc. and Caut.). Portion of upper jaw with four molars of a smaller species of Bear, from the Nerbudda, represented of the natural size. The rear molar is much more elongated from before backwards than in the Sewalik species.—B.M. No. 39,720.

Figs. 9 and 9 *a*.—*Ursus Namadicus*. Tibia of Bear, from the Nerbudda, presented by C. Frazer, Esq.—B.M. No. 39,727.

Fig. 10.—Right femur of *Ursus spelæus*, from College of Surgeons, figured for comparison.

Plate P.

Fossil *Otters*, from the Sewalik hills.

Figs. 1, 1 *a*, 1 *b*, and 1 *c*.—*Lutra Palæindica* (Falc. and Caut.). Beautiful specimen of cranium with alveolar ridges very perfect. The zygomatic arches are absent. Shows the alveoli of three incisors on either side, the outer one being slightly larger than the two inner ones. Outside the three incisors is the alveolus of a large canine, followed by the alveoli of four small molars, and last of all by the carnassier and tubercular, the latter greatly developed.

This specimen is also represented in Plate XXVII. figs. 6 and 7. —B.M. No. 37,151.

Figs. 2 and 2 *a*.—*Lutra Palæindica*. Beautiful specimen of lower jaw, left side, including ascending ramus. Shows a portion of canine and of three small molars, the crowns of which are broken off. Behind there is a large carnassier, very perfect; and last of all is the alveolus of the tubercular, which is small in comparison to that of the upper jaw.

This specimen is also represented in Plate XXVII. fig. 8.—B.M. No. 37,152.

Figs. 3 and 3 *a*.—*Lutra Indica*. Two views of skull, upper and lateral, of existing Indian Otter.

Figs. 4, 4 *a*, and 4 *b*.—*Enhydriodon ferox*.[1] A new fossil genus of otter from the Sewalik hills. Three views of cranium, probably female, much mutilated. Shows on right side the posterior of the two false molars, the carnassier and the tubercular. The anterior premolar, which is deciduous, is wanting. The remarkably square form of the carnassier is well seen.

This specimen is also represented in Plate XXVII. figs. 3 and 4. —B.M. No. 37,153.

[1] Subsequently designated *Enhydriodon Sivalensis*. See memoir at p. 331.

Figs. 5 and 5 *a*.—*Enhydriodon ferox*. Fine specimen of anterior portion of cranium of an old individual, with very perfect alveolar ridges. Shows on either side the alveolus of a large outer incisor, which evidently served as a subsidiary canine. The middle incisors are not only wanting, but the alveoli are completely filled up and obliterated. The canines, which are broken across, are seen to be very large, and were evidently of great strength and massiveness. All trace of the first molar, which is very small and deciduous, has disappeared. The second molar has two fangs, and is encircled by a rugged basal ridge. The carnassier is very remarkable, and presents the prominent feature of the genus. It is nearly square, instead of being triangular, as in both Lutra and Enhydra; and instead of the cusps and trenchant ridges of Lutra, or the flattened inequalities of Enhydra, the coronal lobes are developed into cervical mammillæ, somewhat like those of the Mastodon. A more detailed description of this tooth will be found in the memoir on 'Enhydriodon' (See p. 335). Behind the carnassier, the tubercular is seen *in situ*.

This specimen is also represented in Plate XXVII. fig. 5.—B.M. No. 37,155.

Figs. 6, 6 *a*, and 6 *b*.—*Enhydriodon ferox*. Fine specimen of anterior portion of cranium of a young and probably female individual. Shows three incisors on either side, the two inner of which are very much compressed laterally, so that their antero-posterior diameter is three times that of their width. The outer incisors are remarkably large, as are also the canines. The left canine has dropped out, leaving a large oval alveolus; the right canine is seen in section. Behind the canine, on either side, is an extremely small empty alveolus of the first deciduous molar. Then comes the bicuspid second molar, the peculiar, square, mammillated carnassier, and the tubercular.

This specimen is also represented in Plate XXVII. figs. 1 and 2. —B.M. No. 37,154.

Plate Q.

Carnivora, from the Sewalik hills.

Figs. 1, 1 *a*, and 1 *b*.—Skull, showing palate and teeth, of a fossil species of *Canis*? from the Sewalik hills.[1]—B.M. No. 40,183.

Figs. 2, 2 *a*, and 2 *b*.—Skull, showing palate and alveoli of entire dental series of a fossil species of *Canis*? from the Sewalik Hills.—B.M. No. 37,150.

Fig. 3.—Fragment of palate, right side, with two posterior molars of fossil *Canis*?—B.M. No. 40,180.

Figs. 4, 4 *a*, 4 *b*, and 4 *c*.—*Ursitaxus Sivalensis*. Very perfect cranium and face of a species of Ratel from the Sewalik hills. This appears to be the specimen of fossil '*Gulo*' described by Messrs. Baker and Durand, in the Journ. As. Soc., vol. v. p. 582, and figured in Plate XXVII. fig. 5, of the same volume (See *antea*, p. 351).—B.M. No. 40,184.

[1] Another specimen belonging to Dr. Falconer, and labelled by him 'Skull of fossil *Canis*, from Sewalik hills,' has, since his death, been added to the collection in the British Museum. Along with the skull are portions of the femur, tibia, and bones of the foot.

Plate R.

Fossil Remains of Birds from the Sewalik hills.

Figs. 1 and 1 *a*.—Cervical vertebræ of a bird.—B.M. No. 23,105.

Figs. 2, 2 *a*, 2 *b*, 2 *c*, and 2 *d*.—Lower end of tibia.—B.M. No. 39,732.

Figs. 3, 3 *a*, 3 *b*, and 3 *c*.—Lower end of ditto.—B.M. No. 39,735.

Figs. 4, 4 *a*, and 4 *b*.—Lower end of ditto.—B.M. No. 39,737.

Figs. 5, 5 *a*, 5 *b*, and 5 *c*.—Lower end of ditto.—B.M. No. 39,734.

Fig. 6.—Lower end of tibia of a bird, recent.

Figs. 7, 7 *a*, and 7 *b*.—Fragment of wing-bone.—B.M. No. 39,740.

Figs. 8, 8 *a*, 8 *b*, and 8 *c*.—Fragment of ditto.—B.M. No. 39,738.

Figs. 9 and 9 *a*.—Upper end of metatarsal bone.—B.M. No. 39,741.

Figs. 10, 10 *a*, and 10 *b*.—Fragment of wing-bone.—B.M. No. 39,744.

Figs. 11, 11 *a*, and 11 *b*.—Fragment of ditto.—B.M. No. 39,743.

Figs. 12 and 12 *a*.—Fragment of ditto.—B.M. No. 39,739.

Figs. 13, 13 *a*, 13 *b*.—Fragment of ditto.—B.M. No. 39,742.

Figs. 14, 14 *a*, and 14 *b*.—Fragment of tarso-metatarsus.—B.M. No. 39,736.

Figs. 15, 15 *a*, 15 *b*, 15 *c*, and 15 *d*.—Phalanx of large bird.—B.M. No. 39,733.

Among Dr. Falconer's papers were also found numerous outline sketches on tracing paper of Sewalik fossils, &c., belonging to the *Ruminantia* and *Reptilia*, intended for the Fauna, but which had never been engraved. These tracings have been pasted on sheets of paper, and deposited with the seventeen unpublished plates in the Library of the Geological department of the British Museum. They are as follows:—

A. Ruminantia.

Sheet 1.—Four views of skull of European bison, recent.

Sheet 2.—Four views of skull of Indian bison, recent.

Sheet 3.—Four views of skull of wild Indian buffalo, recent.

Sheet 4.—Four views of skull of *Bubalus brachycerus*, recent.

Sheet 5.—Skull of *Bos primigenius*, for comparison.

Sheet 6.—Restoration of head of *Bos Palæindicus*, including anterior portion of face and horn, figured in Plate G. figs. 6 and 7.

Sheet 7.—Fragment of horn of *Amphibos acuticornis*.

Length of fragment along great curvature, 18·2 in. Chord of lesser curvature, 11·8 in. Great diameter at larger end, 3·7 in. Thickness at ditto, 2·7 in. Circumference at smaller end, 8· in.

Sheet 8.—Skull of *Amphibos acuticornis* (See *antea*, p. 547), including fragments of both horns and both orbits, but greater part of face deficient.—B.M. No. 36,666.

Length of fragment, 10·1 in. Between mastoid angles, 6·5 in. Between external angles of condyles, 3·8 in. Breadth of cranium beneath cores, 4·1 in.

Breadth of cranium in front of cores, 6·4 in. Breadth of cranium between posterior angles of orbits, 7·7 in. Height of occipital facet from lower border of occipital foramen, 3·7 in. Diameter of condyle, 2· in. Height of occipital foramen, 1·2 in. Breadth of ditto, 1·2 in. Diameter of orbits, 2·3 in. Length of three true molars, 3·2 in. Width of alveoli, 1·1 in. Width of palate, 2·9 in. Diameter of core at root (greatest), 2·7 in. Circumference of ditto, 8· in.

Sheet 9.—Figs. 1 to 3, and fig. 4. Two specimens of portion of skull of *Hemibos triquitriceras* (See *antea*, p. 546). Fig. 4 includes the orbit, palate, and molars, but the posterior portion of the skull is broken off. Its dimensions are as follows :—

Length of fragment, 14·3 in. Length of three true molars, 3·3 in. Length of three true molars and last premolar, 4· in. Breadth of alveoli, 1·2 in. Width of palate posteriorly, 2·3 in. Between mastoid angles, 6·2 in. Breadth of cranium beneath cores, 4· in. Breadth of cranium between posterior angles of orbits, 7·3 in. Breadth of cranium between most projecting points of maxillary bones, 5·3 in. Height of occipital facet from lower border of foramen magnum, 4·1 in. Great diameter of orbit, 2·4 in. Great diameter of root of core, 3·1 in. Thickness of ditto, 2·7 in. Length of fragment of core, 6·2 in.

Sheet 10.—Portion of skull of *Bos Sivalensis* (See *antea*, p. 280).

Length of fragment, 12·7 in. Breadth of cranium behind orbits, 8·7 in. Breadth of cranium between posterior angles of orbits, 10·4 in. Width of alveoli, 1·1 in. Width of palate posteriorly, 3·5 in. Diameter of orbit, 2·5 in. Height of cranium from palate in front, 7·4 in.

Sheet 11.—*Antilopidæ*. Figs. 1, 2, and 3 represent the skull of *Antilope Palæindica* (Falc.), No. 39,594 in B.M. This is the skull described and figured by Captain Baker in the Journ. As. Soc., vol. xii. p. 770, and which is also represented in Plate XXIII. (See *antea*, p. 290.)

Sheets 12 to 18.—Represent numerous fossil remains of *Antilopidæ*, *Cervidæ*, &c.

B. Reptilia.

Sheet 1.—*Crocodilus bombifrons*. Fossil Crocodile, from the Sewalik hills (See *antea*, p. 355). Ten figures, illustrating different portions of the skull. Figs. 1 and 2 correspond to British Museum Spec., No. 39,795; figs. 5 and 6 to B.M., 39,796; and figs. 8 and 9 to B.M. 39,797.

Sheet 2.—*Crocodilus bombifrons*. Other specimens of the skull. Figs. 1 and 2 correspond to British Museum Spec., No. 39,799; figs. 3 and 4 to B.M., 39,800; figs. 5, 6, and 7 to B.M., 39,801; and figs. 8, 9, and 10 to B.M. 39,798.

Sheet 3.—*Crocodilus* (*Leptorhynchus*) *crassidens*. (Falc. and Caut.) Fossil Crocodile from the Sewalik hills. Five specimens are figured of different portions of the skull; four of which correspond to specimens in the British Museum, Nos. 16,218, 39,802, 39,803, and 39,804.

Sheet 4.—*Crocodilus* (*Leptorhynchus*) *Leptodus*. (Falc. and Caut.) Fossil Crocodile from the Sewalik hills. Four different specimens of cranium, which correspond to the specimens in the British Museum, Nos. 7,453, 39,805, 39,806, and 39,807.

Sheet 5.—*Crocodilus* (*Leptorhynchus*) *Gangeticus*. Fossil Crocodile from the Sewalik hills, identical with modern Gavial. Three specimens of different portions of skull, which correspond to the following catalogue numbers in the British Museum, viz., 36,647, 39,809, and 39,810.

Sheet 6.—*Crocodilus* (*Leptorhynchus*) *Gangeticus*. Five specimens of different portions of cranium and jaws, four of which correspond to the following catalogue numbers in the British Museum, viz., 36,726, 39,808, 39,811, and 39,812.

Sheet 7.—*Crocodilus* (*Leptorhynchus*) *Gangeticus*. Portion of cranium, vertebræ, and other parts of skeleton. Correspond to British Museum numbers, 17,006, 39,811 *a*, 39,813, 39,814, 39,815, 39,816, and 39,818.

Sheet 8.—Skull and jaws of Crocodile.

Sheet 9.—*Colossochelys Atlas* (Falc. and Caut.), from the Sewalik hills. Different specimens of episternal bones.

Sheet 10.—*Colossochelys Atlas*. Entosternal and xiphosternal bones, margin of carapace, &c.

Sheet 11.—*Colossochelys Atlas*. Portions of carapace.

Sheet 12.—*Colossochelys Atlas*. Humerus, fragments showing upper and lower ends, &c.

Sheet 13. — *Colossochelys Atlas*. Specimens showing ulna, pubes, ischium, femur, &c.

Sheet 14.—*Colossochelys Atlas*. Foot bones.

Sheet 15.—Fossil *Emydæ*, from the Sewalik hills. Portions of carapace.

Sheet 16.—Fossil *Emydæ*, from the Sewalik hills. Carapace.

Sheet 17.—Fossil *Emydæ*, from the Sewalik hills. Carapace.

Sheet 18.—Fossil *Emys tecta*, from the Sewalik hills, identical with existing species (See *antea*, p. 384). Two specimens are figured corresponding to Nos. 39,837 and 17,435 in the British Museum catalogue.

Sheet 19.—Fossil *Trionyx*, from the Sewalik hills and the Nerbudda.

Sheet 20.—Fossil *Trionyx*, from the Sewalik hills.

XXVIII. OFFICIAL REPORT OF EXPEDITION TO CASHMEER AND LITTLE TIBET IN 1837–38.

BY H. FALCONER, M.D.[1]

To F. Currie, Esquire, Secretary to the Governor-General, North Western Provinces.

SIR,—In compliance with the orders of the Right Honourable the Governor-General, I have the honour to submit a summary of my proceedings whilst on the deputation on which I was ordered to Cashmeer, and of the results of my journey.

2. Having received the orders of the Government, communicated in a letter from Mr. Secretary McNaghten, addressed to Captain Wade, political agent, Loodianah, dated the 22nd May, 1837, to proceed on the mission with Lieutenant Mackeson; and, having provided the materials and necessaries required for a collection in Natural History, I started from Suharunpoor on the 29th June, and joined Captain Wade on the banks of the Sutlej on the 1st July.

3. His Highness the Maharajah having granted permission for my proceeding to Lahore, and thence through the Punjab, to join and accompany Lieutenant Mackeson in the capacity of a medical attendant, I separated from Captain Wade on the 6th July, after having had the benefit of every assistance which that officer could afford towards the comfort and facility of my journey, and of advice regarding my conduct in the countries which I was likely to visit. I started from Loodianah on the 9th July, and arrived at Lahore, *viâ* Kupoorthulla and Amritsir, on the morning of the 13th. I was most kindly and hospitably received by General Ventura, the only European officer then at the Court, the others, with the principal Sikh Sirdars, having been ordered to Peshawur with the army after the affair of Jumrood. I was admitted to an audience with His Highness on the 15th, and received by the Maharajah with the usual marks of attention and consideration which he exhibits in his intercourse with British officers. I learned on this occasion that Captain

[1] This report is now for the first time published. Although nearly thirty years have elapsed since it was written, it will still be read with interest.—[ED.]

Burnes had already arrived at Kala Bagh, and was *en route* to Attock, which information induced me to urge upon His Highness the favour of an early departure from Lahore, so as to give me the chance of joining the Caubul Mission party before they crossed the Indus. My request was acceded to, and on the 17th I was admitted to an audience of leave. On the 18th I set out for Attock.

4. It had been my intention, originally founded on the information which I got from Captain Wade regarding the progress of Captain Burnes up the Indus, to proceed from Lahore to Pind Dadun Khan, and thence to Kala Bagh with the object of examining the structure and productions of the salt range, so remarkable a feature in the physical geography of the Punjab; but the advance of the mission compelled me to forego this object, and to follow the direct route to Attock. I reached Vazeerabad on the Chenab in three marches, and thence I went to Rotas[1] *viâ* Buerwal and Jhelum; from Rotas I proceeded by Bukrala Bishendour and Maukejalla to Rawul Pindee, and thence by Kale Sura to Hussein Abdul, where I had the satisfaction of joining Captain Burnes' party, and of meeting with Lieutenant Mackeson, the companion of the journey which I had in prospect.

5. My further movements were now dependant on those of Lieutenant Mackeson, and I found that that officer, in pursuance of instructions from Captain Wade, purposed to proceed to Peshawur. This decision caused me some perplexity. Hussein Abdul is a point where the road diverges respectively to Cashmeer and to Peshawur. Cashmeer was the destination which the Government pointed out for my investigations in Natural History; and the season for collecting with advantage in botany was already far advanced, and, as regarded the hill tracts around Cashmeer, it was rapidly passing by. If I went on to Peshawur, and subsequently got to Cashmeer, I could, at the best, but expect to arrive there about the end

[1] 'I beg to inform you that one of the most interesting results at which I have arrived has been the finding of fossil bones and other organic remains along all the points of the Sub-Himalayan range on which I have touched, from Jhelum on to near Rawul Pindee, and that these fossil bones have proved identical with those which are found in the Sewalik or Sub-Himalayan range between the Jumna and Sutlej, thus establishing the identity of the tertiary formations along the foot of the Himalayahs from the Ganges to near the Indus, a point of much interest in the physical history of the mountain range.'—*Extract from Official Report by Dr. F. to Captain Wade, July*, 1837.

'I got our Sewalik fossils on beyond the Jhelum, proving the protraction of the range as far nearly as the Indus, and I got fossil shells, apparently recent, like our Sewalik casts, in a superficial bed of the salt formation near Rotas, in a sandstone associated with crocodilean remains. I had only half an hour one evening to give to the inquiry.'—*Letter from Dr. F. to Captain Cautley, Cashmeer, January* 11, 1838.—[Ed.]

of autumn, when a great part of the flora would have disappeared, or waned into the fall of the leaf. I had the option of two alternatives—either to proceed to Peshawur or to continue at Hussein Abdul, till such time as the Maharajah should concede his permission to my going on to Cashmeer. For it had not hitherto been intimated to His Highness, in the communications made by Captain Wade, that Cashmeer was the direction in which it was intended that I should be sent. I had been mentioned on all the occasions on which my name had been referred to simply in the capacity of a medical attendant with Lieutenant Mackeson, and that officer had as yet received no reply to an application which he had made to the Maharajah from Kala Bagh for permission to pay a visit to Cashmeer, accompanied by me. Under these circumstances, I deemed it expedient, with the concurrence of Lieutenant Mackeson, to proceed with him to Peshawur. This determination afforded an opportunity of examining the productions of a country which had not hitherto been botanically surveyed.

6. From Hussein Abdul the Mission moved on to Attock, a halt at which place and at Khyrabad led to the detection of numerous plants new to the flora of the North of India. On arrival at Peshawur, it appearing probable that the Mission would remain some time there, I applied to Captain Burnes for his sanction and assistance to go on to Kohat, and the hills around the valley of Bunguish, with the object of examining the salt range and the district reported to contain coal. That distinguished officer entered zealously into the design, and made arrangements which enabled Dr. Lord and myself to proceed, General Avitabile, the Governor of Peshawur, and Sirdar Sultan Mohamed Khan, having readily acceded, and given their best aid to our undertaking the journey. In consequence of the then recent affair of Jumrood the country was in an excited and disturbed state, which the arrival of the British Mission at Peshawur did not tend to diminish; and we were impressed by General Avitabile with the necessity of some caution in our procedure. We started from Peshawur with an escort, supplied by Sultan Mohamed Khan, on the 15th August, and halted at Andavre; from that we moved by a long night march to Kohat; thence to Hangoo, at the upper end of the Bunguish valley, with the purpose of proceeding to Nuryoob, one of the reported coal localities. But the country was so disturbed that we were not permitted to proceed, and we had to return to Kohat. By the assistance of Sirdar Sultan Mohamed Khan, who had by this time arrived at Kohat, we again set out; and proceeded in the direction of Lachee,

near which we had an opportunity of examining one of the beds reported to be coal, and the great salt bed at Jutta. The coal proved to be a subordinate bed of bituminous shale, included between the arenaceous strata of the salt formation and an overlying stratum of fibrous gypsum. Although an anxious search was made both by Dr. Lord and myself, neither of us came upon any organic remains, vegetable or animal, either in the sandstone or in the shale.[1] Neither our time nor the state of the country admitted of our examining the other reputed localities near Khoorpa and Nuryoob; but as the geological features of the country were exhibited on a great scale, and displayed much uniformity of character throughout, it is probable that no considerable difference could have been found in these. I arrived at the opinion that there are no grounds to believe that any considerable coal deposit exists in the salt range, the specimens discovered proving to be either mineral pitch or bituminous shale,[2] and that shale containing not a trace of organic remains, or anything resembling a vegetable impression. It appears probable to me that the carboniferous bed discovered by Lieutenant Wood near Kala Bagh is of a relatively modern era, so to speak, compared with any great system of coal measures, and that the mineral does not occur there or at any point in the salt range near the Indus, of a description and in a quantity fit to be worked for fuel. In connection with this point, I may here add that the 'coal' of the Sewalik hills, mentioned by Dr. M'Clelland and in the Report of the Coal Committee, as found near Hurdwar, is a tertiary 'lignite,' occurring in thin seams or in detached masses, formed probably by the bituminization of single portions of wood washed into the alluvium during the deposition of the strata; and after an extensive examination of the Sub-Himalayah Hills, from the Ganges on to the Sutlej, and at several points between that river and the Indus, I am of opinion that there are no grounds to believe that a coal formation anywhere exists along the tract, or that the mineral is to be found in any other state than that of isolated masses or thin seams of lignite.

7. From Jutta we returned to Kohat, where we had an interview with Sultan Mohamed Khan, who had displayed every inclination to further the objects of our journey to the utmost of his ability. He possesses a certificate from Mr.

[1] In a letter to Captain Cautley, however, dated Cashmeer, January 11, 1838, Dr. F. observes: 'I got fossil remains in a limestone near the salt range close to Kohat.'—[Ed.]

[2] It is a most highly bituminized pitch coal, compact and very splendent, and so inflammable as to catch fire in the flame of a candle, and burn freely, caking and leaving a spongy coke.—*Letter to Captain Cautley*, 1838.—[Ed.]

Moorcroft, expressing in the strongest terms the sense entertained by that lamented traveller of his friendly services, and of his being better disposed towards Europeans, and those of the British nation in particular, than any of the other Barukzye chiefs. At our last interview, he exhibited another example of the lengths to which Afghan noblemen carry their feuds, and of the sacrifice of every other consideration to personal feeling, in requesting Dr. Lord to impress upon Captain Burnes that if he retained any kindly recollection of his (Sultan Mohamed's) former friendship, he (Captain Burnes) must not allow the Sikhs to come to terms with his hated brother, Dost Mohamed, but thwart this object by every means in his power. We moved from Kohat on the 24th, and returned to Peshawur, where we found Captain Burnes preparing to start for Caubul. This journey to the valley of Bunguish enabled me to make a considerable collection of the plants which characterize the lower parts of Afghanistan bordering on the Indus.

8. Lieutenant Mackeson had by this time received a favourable answer from his Highness the Maharajah to his application for permission to go to Cashmeer, and determined to proceed on the departure of the Mission for Caubul. On the 30th we embarked in a boat and floated down the Lundye, or Caubul river, to Attock, where we arrived on the 31st. We halted some days to make the necessary arrangements for carriage, and in expectation of the arrival of the attendant appointed by the Maharajah to escort us, we received a visit from Rajah Goolab Sing, of Jummoo, who displayed not a little anxiety about the objects of our visit to Cashmeer, and the direction in which we should move on leaving it. Having completed our equipment, it appeared desirable, in furtherance of the objects for which we were deputed, to follow different routes if possible. Lieutenant Mackeson determined to go by Drumtour and Mazufurabad, with the design of making a map of the military road by which the Afghans had generally entered the valley, and by which the traffic with Caubul was still pursued. In concurrence with that officer, I resolved on making an attempt to run up along the eastern bank of the Indus as far as Derbend, in the first instance, and thence to be guided by circumstances, either in pushing further up if practicable along the valley of the river, which had not been explored at this portion of its course, higher than Derbend, or, failing that, to turn eastward across the mountains, through Thunaolee to Mazufurabad, and thence rejoin Lieutenant Mackeson. The road lay through a wild tract, occupied by fierce and lawless tribes—at deadly enmity, and engaged in constant

struggles with the Sikhs. But it appeared probable that if Poynda Khan, the chief of Thanaolee, should prove favourably inclined, the difficulties of the journey would be materially diminished, and the friendly reception which he had lately given to Lieutenant Leach afforded every countenance to the idea that he would not act otherwise. While at Huzroo, an incident occurred exhibiting in a strong light the barbarous kind of rule under which the country is governed. Two Mussulmans were suspected to have murdered a Hindoo muleteer. The Sikh officer at Huzroo, instead of awarding punishment himself, made them over to the caste of the murdered man, to be dealt with as they thought proper; and the unfortunate wretches were burnt alive under circumstances of the most aggravated torture.

9. We started in company from Attock for Huzroo, where, having left my baggage and collections to proceed along with Lieutenant Mackeson, I separated from that officer on the 7th September, and set out for Torbela with a few attendants, and few articles besides paper for plants and some other necessaries. The beautiful plain of Chuch, which appears to have been formerly a lake of the Indus, abounds in the richest capabilities of soil, but being the debateable ground where the mutually embittered Hindoo and Mussulman races meet, it is in a great measure uncultivated and in waste. We reached Gazee about midday, but considering it unsafe to remain there, pushed on for Torbela, which we reached in the evening. A little beyond Gazee, the plain of Chuch ceases, being cut off by a spur from the 'Ghodreh' ridge, above which the course of the river is entirely within mountains, and its valley greatly contracted. We passed a few scattered huts, and had some difficulty in pushing on and escaping from the civilities which the rough-mannered Pathan inhabitants pressed upon our small party. As we advanced, the valley of the river became more and more confined, the road leading along or upon its alluvial sand. The character of the vegetation was unexpected, consisting of many of the plants which are found in the Dhoons or Sub-Himalayan valleys of Hindostan, such as species of *Grislea*, *Rœttlera*, *Hastingia*, *Ehretia*, *Acacia*, *Colebrookia*, &c.; and the *Dodonœa Burmanniana*, supposed to be peculiar in India to the Peninsula, was seen in great abundance. As we approached Torbela, the valley gradually expanded till we reached the broad and level tract upon which the town is built. We were conducted to an open garden, where the former chief, Munsoor Alli-Khan, waited on us, and showed us every civility. The next day I had to halt, to arrange for a guide to conduct us to Derbend. The Torbela chief held

back at first from supplying one, professing to be afraid of giving offence to the Sikhs, whose hard rule he had experienced during a five years' imprisonment at Lahore, the Sikhs in Torbela fort having evinced by some marks of rudeness that they were not pleased at our advent. Having gained, by the promise of a reward, a person to accompany us, I started on the morning of the 9th for Derbend. The path lay along the banks of the river through a rugged and broken tract. We saw but one small hamlet, and some Sikh watch-towers, the cultivation having disappeared in the struggle between the Sikhs and the Thanaolee chief. Before noon we got to near the fort of Deyra, along a belt of level ground which skirts the river. The Castle of Umba, a hold of Poynda Khans, was seen on a rock overhanging the river, on its further bank, with the Sikh fort on the eastern side. Nearly opposite to it, in passing, we were hailed by the Sikhs and desired to go up the hill. We found ourselves in the midst of a large party of soldiers. They were greatly excited, and used rude language and threats, and averring that we had come on with an unfriendly purpose towards them, and with the design of visiting Poynda Khan, which they were resolved to prevent. The unlucky guide, Hussein Alli, was seized, pinioned, and beaten, and some of the more violent of them proposed the same treatment for the whole party. No leader was distinguishable among them, the band consisting of a rabble of soldiers. After some hours' detention, and much quiet remonstrance, the guide was liberated, and we were allowed to return without further molestation, permission to go to Derbend, about three miles higher up, being peremptorily refused. Two alternatives remained, either to cross the river below Umba, and meet Poynda Khan, or to turn across through Huzara on the route followed by Lieutenant Mackeson. The former course had been pressed upon me at Torbela, but I declined it, being unwilling to go openly to a chief who was at declared enmity with his Highness the Maharajah, through whose country and under whose protection we were moving as favoured guests. After what had occurred at Deyra, this consideration had additional force; and however disinclined to forego a journey higher up an unexplored part of the Indus, I resolved to take the Huzara route, and rejoin Lieutenant Mackeson. We followed the course of the river about half way back to Torbela, when we turned eastward from the valley along the summit of a low ridge, and about sunset reached a village held by a family of Seyads, to whom our guide explained the circumstances of our journey, and we were hospitably entertained by them. It proved afterwards

that the interruption which we had met with was owing to secret orders to the purpose given by Maun Sing, the Sikh Sirdar of Huzara. Recent events had created a ferment among all the Pathan tribes then at enmity with the Sikhs, and it did not appear to him desirable that a European should be permitted to pass through so unsettled a tract of country at such a juncture.

10. Poynda Khan is the only chief who has been able to maintain his ground against the Sikhs, in the Hill States between the Indus and Cashmeer, and he has, in consequence, a great local celebrity. His father, Nawab Khan, was famous for infesting the lower part of the Cashmeer road, which his country of Thanaolee commanded. On the return of Mohamed Azeem Khan from Cashmeer, after repelling the first unsuccessful attack made upon the valley by the Sikhs, he followed the Thanaolee road to Derbend, and inveigled the chief to an interview. Nawab Khan was received with distinction, but on a signal from the Afghan Sirdar he was treacherously seized, and thrown, with a stone round his neck, into the Indus. His son Poynda Khan, then a stripling, who accompanied him to the interview, rushed out, threw himself into the river, swam across, and escaped. He soon after came into collision with the Sikhs, whom he successfully resisted for a long time; but he was gradually driven back, and lost the lower part of Thanaolee and the fort of Derbend. The rest of the country he still holds, keeping the Sikhs near him in a constant state of alarm. Thanaolee is the highest Pathan country upon the east bank of the Indus, the tract between it and Little Tibet being occupied by numerous tribes of Dardohs, a distinct race, who have a peculiar language called Dangree, and do not speak Pushtoo.

11. On the morning of the 10th we parted from the hospitable Seyads, and descended into the valley of Huzara, where our guide was dismissed. We came upon the high road to Cashmeer at Haripoor, whence we moved to Chumba, and rejoined Lieutenant Mackeson there. From Chumba our road lay through Drumtour, Mohunsa, and Saadut Khan Ke Ghuree to Mazufurabad, where we entered the country of the tribes called 'Kukas' and 'Bhumbas.' Here the province of the Governor of Cashmeer commences, and we found an officer with an escort waiting by his orders to receive us. From Mazufurabad there are three roads leading to Cashmeer—1st, the eastern or Doarbid road, in the valley of the Jhelum river, by which commerce is conducted; 2nd, the Sungur or middle road along the ridge which separates the Kishen Gunga from the Jhelum; 3rd, the Luchraut or western road,

along the valley of the Kishen Gunga, by which Mr. Forster travelled in 1783. Lieutenant Mackeson followed the first, and I took the second. Mazufurabad, my route, lay by a steep and severe ascent from the valley of the Kishen Gunga to a small village called Patlee; thence along the ridge of one of its shoulders to an elevated mountain, called Peer Choonassee, richly covered with forest and alpine vegetation, and which yielded a large accession of specimens to the herbarium. We passed the night a little below the summit, and descended by a long and steep slope to Gunguni in the district of Punjcote. From Gunjunee the road again touched on the Kishen Gunga, and conducted us to the village of Teetival in Kurnah. From Teetival we passed up through the fertile and highly cultivated valley of Kurnah to Tungtar. We had here arrived at the foot of the pass which leads into Cashmeer on the morning of the 23rd. We ascended by an easy slope through a dense forest of pines, sycamores, and horse-chestnuts. On emerging from the upper limit of the forest the ascent was seen to be steep for a short distance, but not so much as to be impracticable for a mounted horse. From the summit of the pass, which is called Nutthoo Chunna, we had our first view of Cashmeer, as confined to a small portion of the north-western end of the valley. We descended and reached Ummur Ghur, in the Pergunnah of Oontur. From Ummur Ghur I moved on through the plain of Kamraj, passed down the river from Sopur, and rejoined Lieutenant Mackeson at Baramula, on September 26th. Thence we moved up towards the city of Sopur, and thence to the city of Cashmeer, which we entered on the 30th. By the orders of the Maharajah we were received with every mark of consideration by the Governor, Colonel Meean Sing.

12. Lieutenant Mackeson, soon after our arrival, received instructions from Captain Wade to return to Peshawur with all practicable speed, and made his arrangements for leaving the valley immediately. It became necessary for me to decide on the course which I should adopt. The season for collecting plants had nearly gone by before we reached Cashmeer, and in consequence I had been able to gather but a small portion of the flora. There was nothing that required me to accompany Lieutenant Mackeson to Peshawur, and were I to return through the hills to Hindostan, the object for which I had been sent would have been very imperfectly accomplished. I therefore resolved to winter in Cashmeer, and complete my collections in the spring and summer. I communicated my resolution to Captain Wade, with the reasons that had led me to form it, which met with the con-

currence of that officer. The Governor of Cashmeer received the intimation with courteous professions of satisfaction, and there was no reason to believe that it would meet with any marks of disapprobation from the Maharajah, after the ready compliance with which His Highness had been pleased to accede to our journey.

13. My proceedings during the next eight months which I passed in Cashmeer[1] must be embraced here in a very brief summary. On the departure of Lieutenant Mackeson I was occupied in that portion of the valley which lies in the vicinity of the city, in company with Mr. G. T. Vigne, well known in India as an enterprising traveller. This gentleman had returned from an attempt to penetrate to the sources of the Noorba river, one of the two great branches of the Indus, in which object he had been defeated by the ill-disguised opposition of Rajah Goolab Sing of Jummoo. Before the winter set in with severity I made an excursion to the Mut-

[1] The following account of Cashmeer, taken from a letter addressed to Captain Cautley by Dr. F., in January 1838, will be read with interest:

'A glance at any map will show you the figure of Cashmeer—a deep valley surrounded on all sides by lofty snowy mountains. The valley consists of two levels, one along the basin of the river Jhelum, and another called *Krewa*, or dry land, like the high land at Kheeri. The river traverses the whole length of Cashmeer, and its course is so very slow that it looks more like a huge canal than anything else, with countless serpentine bends. All round the valley tributary streams fall into the river, and here and there are lakes, one of large size. At intervals all along the foot of the surrounding mountains there are low hills of traps, which break out from the level of the valley. The city is situated between two such hills, and it is so completely surrounded by lakes that it appears to rise out of the water. These trap hills add vastly to the beauty of Cashmeer. Conceive this romantic situation—the lakes covered with water-lilies, cotton (a poor sort, certainly) growing on the banks, deodars and pines sheeting the sides of the hills, noble plane trees loaded with verdure, apple-trees covered with red-cheeked English-looking apples and as good as they look, pear trees with pears, the most delicious grapes, air the picture of transparency, a heavenly temperature, and everything looking divine. In my idea, all the praises bestowed on Cashmeer are amply merited.'

* * * *

'The oppression of the Sikhs is beyond bounds. Nothing from the unborn babe upwards escapes it. They accuse the Cashmeerees of being a false and treacherous race, and as deserving nothing better than *Zulm*; but if they are so, it is oppression that has made them what they are. Excepting the Governor, and two religious families, there is not a native in the valley to whom you would give a chair, so completely have the respectable ranks disappeared. The only Hindoos in the valley are the famous Pundits of Cashmeer. They amount to many thousand families, and they are the scorpions of the valley. They engage in no occupation save the collection of the revenue. They are quartered to an oppressive extent on every village, and are the only servants of the Government, to the almost utter exclusion of the Mussulmans. They are a fine race of men—sleek and well to do with the world in appearance, even the meanest of them. Their women are exceedingly fair—almost European—and certainly the beauties of the valley, with red cheeks and white complexions. The Mussulman women have a coppery-yellow tinge—they say from the excessive use of tea, which is made in the Moghul fashion, boiled up with salt, soda, and butter—an abominable mess. The butter floats in a thick cake when the tea cools. Tea is universal with all ranks, and at all hours of the day.'—[Ed.]

tayen Pass, which separates Cashmeer from Ladakh, for the purpose of examining the rock formations to the north of the valley.[1] I then returned to the city, where I housed myself and party for the winter, during which I was occupied on the collections which I had made, and in gathering general information regarding Cashmeer and the neighbouring countries. Early in December I was seized with the preliminary symptoms of illness, which from the 17th assumed an alarming form, and from that date till the middle of January I was reduced to a state of extreme prostration, from which I was long in recovering. Early in March I started on a systematic tour around the valley, occupied on the spring flora, which yielded a rich harvest. On June 3rd a confidential servant arrived with a letter from Rajah Ahmud Shah, conveying expressions of friendship and inviting me to pay a visit to Little Tibet. I had previously, during the winter, received a similar communication, and in anticipation of the ability to visit Iskardoh, had applied for the Maharajah's permission to proceed, which his Highness readily granted. As the botany of this region, which forms a connecting link between the Himalayahs and Eastern Turkistan had never been explored, and the present occasion appeared favourable for the accomplishment of so desirable an object, I determined on taking advantage of the Rajah's invitation. I left plant collectors in Cashmeer, so that none of the summer flora might be lost during my absence. There are two great routes by which Little Tibet may be entered from Cashmeer—the Drass road, which leads circuitously through the western end of Ladakh, and the Kooeehamoo road, turning north from the great lake across the Kishen Gunga river. I followed the latter. We crossed the Kooeehamoo Puntsal, and descended upon Goress, on the Kishen Gunga, in two severe marches. The transition takes place here between the productions of Cashmeer and Tibet. The famous 'Prangos' of Moorcroft, so long and fruitlessly sought after, was seen growing in great abundance. I had

[1] 'I have met with a most remarkable volcanic tract in Cashmeer, and, so far as my reading goes, without example elsewhere; a tract of alluvium with the strata elevated at a slight angle, and torrefied up to the surface to the condition of a well-burnt brick; but there is no outpouring of lava, and the tract is very circumscribed. Thirty-three years ago the ground was so hot that the Hindoos of Cashmeer, simply by digging a few inches, were enabled to boil rice by the heat of the under strata. There must have been a layer of incandescent fluid igneous matter underneath; but strange, is it not, that it nowhere reached the surface?'—*Letter from Dr. F. to Captain Cautley, dated Cashmeer, October* 12, 1837.

'Further in Cashmeer I have got from a mountain limestone countless remains of Encrinites, some Corals, and some obscure shells like *Terebratulæ*.'—*Letter from Dr. F. to Captain Cautley, dated Cashmeer, January* 11, 1838.—[Ed.]

previously detected it at numerous points around Cashmeer, but neither there nor at Goress could I find that it was collected as a winter fodder for cattle. My inquiries led me to the belief that this umbelliferous plant is only prized where other herbage is scarce or wanting, as is the case at Drass. A traveller advancing through the sterile regions of Ladakh towards Cashmeer sees in the Prangos a highly valued agricultural product, while another moving from Cashmeer into Tibet finds it neglected.[1] Goress is inhabited by a tribe of Dardohs, a race distinct in manners and language from the people of Cashmeer and of Tibet. The Kishen Gunga is here formed by two streams flowing from the eastward, the one taking its rise on the borders of Kurtakhcheh, a province of Little Tibet, and the other from the hills towards Himbass; but neither of them received any portion of the drainage of Drass, as has been stated by one of the latest authorities. From Goress we ran up the Kurtakhcheh branch in an easterly direction to the village of Zeean, the last place where cultivation is seen, thence to Naigoon, Mukbun-i-blangsa and Runtakhcheh. From this point, after passing through the maidan of Noyah, we returned off from the Kishen Gunga in a northerly direction to the foot of Boorzilla-bal Mountain, part of the lofty ridge which separates the drainage of the Kishen Gunga from that of the Indus. We crossed the pass over extensive beds of snow, and descended through a steep and narrow gorge to Sookarun Murbul, a bleak and rocky tract abounding in the Tibetian Marmot, which we here saw for the first time; thence to the

[1] *MS. Description of the Prangos pabularia, Lind., by Dr. F.*

'No detailed description of this celebrated plant has yet appeared; those given by Wallich and Lindley having been taken from imperfect dry specimens. I had frequent opportunities of seeing the Prangos, in its native state, in all stages of its growth, in Tibet and Cashmeer. The following is the description which I then made of it. For the sake of precision, I shall first give the characters of the flower and fruit in generic fashion, as if the genus consisted of the *P. pabularia* alone.

'*Prangos* Lind. *Flora Medica*, p. 56, D.C. Prod. p. 239.—*Calices*: margo 5-dentatus. *Petala* ovata, integra, apice involuta. *Stylopodia* lata, convexa, crenata, demum depressa, in fructu vix prominula. *Styli* elongati, recurvi. *Fructus* elliptico-oblongus, sectione transversa subteres, commissurâ latâ. *Mericarpia* a dorso subcompressa, suberosa, jugis primariis 5 crassis in alas latas valde undulato-flexuosas, basi ab utroque latere verrucosas expansis. *Vittæ* plurimæ, tenues, semen omnino circumdantes. *Semen* lineare-oblongum, albumine marginibus involuto. *Carpophorum* bipartitum. *Umbellæ umbellulæque* multiradiatæ. *Involucri* utriusque foliola simplicia.—Herba perennis, glabra, foliis tripinnatim-supradecompositis, segmentis linearibus sub divaricatis supra canaliculatis, involucri utriusque foliolis abbreviatis, floribus luteis polygamis: radialibus cujusque umbellulæ plerumque androgynis, centralibus masculis: umbellis inferioribus nunc omnino sterilibus.

'*Prangos pabularia*, Lind. loc. cit.—Hab. passim ad colles apertos Cashmeer et Tibet. In Cashmeer floret Maio: in valle fluminis Kishen Gunga prope Goress florentem legi sub finem Julii. Fructus maturescit Augusto et Septembre.

'In lingua Tibetana "Prangos" vel rite "*Prānlgŏs*;" sed proprius secund. A.C. de Körös "*Ākrŏn*" nuncupatur.'—[Ed.]

site of a deserted village called Bulleh Tseerchoo. We were now close upon the inhabited territory of the Rajah, a village called Dass-i-Kurum, being but two miles off. It had been arranged by Ahmud Shah that I should descend from Boorzillah into Astore, a tributary state upon the Indus opposite Gilghit, held by a nephew of his, called Jubbar Khan. With this intention I had got to Bulleh Tseerchoo; but we found messengers there with intelligence that the Astore chief had exhibited symptoms of disaffection to the Tibet Rajah, and that he was not disposed to give the English stranger any assistance in passing through his country. Soon after a letter from Ahmud Shah apprized me that it was advisable that I should avoid Astore and follow the route of Bearsoh. Relinquishing the Astore direction, we ran up an eastern arm of the valley leading to Deosoh. This great plain, called Bearsoh or Deosoh, constitutes one of the principal features of the Tibetian region. Near Cashmeer, elevated 13,100 feet above the sea, and surrounded by lofty snowy peaks, it forms a nearly level plateau about fifty miles long and forty in breadth, occupying the interval between the Indus and the Kishen Gunga. High above the forest or 'birch' region, its vegetation is restricted to herbaceous species, and a few dwarf willows; but these are so abundantly produced as to clothe it with verdure. We halted on the plain at Chukinun-Kurroo, proceeding thence in an easterly direction to Alli Mullik-i-Mat, where we turned north, and ran up a lateral branch of Deosoh, which gradually contracted into a ravine, and conducted us to the foot of the Boorgee Pass. A nearly perpendicular ascent of 600 feet brought us to the summit, which I found to be elevated 15,600 feet above the sea.

14. The Boorgee Pass commands an extensive view of the mountains which stretch beyond the Indus towards Turkistan, and of part of the immediate vicinity of Iskardoh. The verdure of Cashmeer was still fresh in our recollections, and the plain of Bearsoh, which we had just left, after journeying three days along it, although destitute of trees was sheeted over with herbaceous vegetation. The prospect which now opened upon us was contrasted in every respect. Looking down through a gloomy gorge, we saw a level tract below, and countless lines of mountains running off into the remote distances. But there were no signs of vegetation visible; sterile sand, and naked rugged rocks, met the view on every side. We descended the pass by a steep and most difficult path to Kunkera Marphoh. Next day we continued our descent, the gorge contracting as we advanced till it was reduced to a narrow and nearly vertical cleft, across which a military wall is built. Here, on the 8th of August, I met

Rajah Ahmud Shah, who had come a day's journey from Iskardoh to welcome me to his country. After a short halt, we continued our descent, and reached the village of Khurpeetah in the plain of Iskardoh. Next day we moved on to the castle.

15. I remained in the neighbourhood of Iskardoh till the 14th, when I crossed the Indus with the object of pushing north in the direction of the Mooztagh range (Kuenlun of Humboldt), which separates the Valley of the Indus from Chinese Tartary. My journey was readily acceded to by Ahmud Shah. I went first to the Castle of Shiggur, on the river of that name, a large feeder of the Indus, which is joined by it opposite Iskardoh. I had the satisfaction of meeting Mr. Vigne here. From Shiggur we crossed to the western bank of the river, to a village called Bondoh; thence to Goma Ghondoo, Keyok, and Chookoogoh. From Chookoogoh, we moved on to Chitrone, remarkable for its hot spring and baths, and thence up the Basha river to Sezkoh, and from there to Betsul, where there are considerable sulphureous hot springs. From Betsul we proceeded to Arindoh, the extreme limit of cultivation in the Basha Valley, and the point where the river of that name bursts out from under a great ice field.[1] From Betsul we retraced our steps to Sezkoh, and thence to Tongo, descending along the eastern bank to the point where the Basha and Braldoh streams unite to form the river of Shiggur. We now turned up the the Braldoh Valley, which forms the route of communication between Little Tibet and Yarkund, passing through Myeet, Byanoh, Hotoh, and Thongul to Askolee, in as many marches. The rugged impracticable nature of the road beggars description; the utmost that can be said of it is that we were able to get along. At Askolee, in lat. of about 35° 30′, we reached the limit of cultivation; all beyond, on to the pass across the Mooz-

[1] 'I have just returned from Iskardoh, where I pushed on to the Mooztagh. It is the most singular country I ever saw; nothing but sand in the valleys below, and burnt sterility above to the region of snow, under which a faint attempt at vegetation exists. The country is all primitive, and such rocks and such mountains never were seen. They seem to have been created to try the ingenuity of man in getting over them. The ice scenery is magnificent. Above there is no snow save a thin coating, but boundless sheets of ice with fearful cracks and crevices. At two places an ocean of ice has tumbled down into a valley and formed a *mer de glace* of two day's journey along it. Within a few hundred yards are fields of cultivation. The ice field rises to some hundreds of feet in height, and is strewed on its surface with countless millions of blocks of granite, &c., and here and there, where soil has formed, there is an attempt at cultivation, with willows, &c. A large river comes out at a cow mouth's opening, and the ice rises clear and transparent above the arch. Some huge masses of ice tumbled down while I was enjoying the view, with the redound of ten thousand artillery.'—*Letter from Dr. F. to Captain Cautley, dated Cashmeer, October* 12, 1838.

tagh, was reported to be a region of ice. It was now the 29th of August. I found that the vegetation, both in the valley and on the mountains above it, maintained a very uniform character as we advanced. I could gather no information that afforded me the least hope of finding the real Rhubarb of commerce, which was an object of constant inquiry and research with me during my journey; the species which I daily saw being identical with those growing on the mountains between Cashmeer and Tibet. To reach Hindostan I had a long journey before me over several ranges of snowy mountains, and the season when snow begins to fall was close at hand. These reasons led me to determine on returning from Askolee without attempting to proceed further north. On the 30th we crossed the Braldoh river to Koorpeh, whence our road led over the lofty mountains of Skora, which we crossed at 16,200 feet above the level of the sea. We turned down upon the valley of Shiggur, and got back to Iskardoh on the 6th of Sept., when I communicated my intention to the Rajah of starting immediately for Cashmeer.

16. Before leaving the country, I went to see the junction of the Shayook and Ladakh rivers, regarding the position of which, and the relative size of the streams, late authorities are much at variance. The confluence occurs at a place called Chundoo, a day's journey above Iskardoh, and about two miles above the village of Gol. The course of the river is here almost due E. due W.; we ran up the southern bank. The valley of the great river (called here Rgemtsoh), was observed to be prolonged in an ENE. direction into the Shayook or Noobra branch, which above the junction bends round to the east. The Ladakh river comes by an abrupt turn from due south, through a narrow gorge, running across the direction of the great river. Advancing as we did, on the side from which it flows, its position was completely hid till we arrived on the brink of the stream. The Shayook river (unknown by that name in Little Tibet, where it is called Noobrasoh), was about 250 yards wide at the junction, but rapid and shallow, while the Ladakh river forms a deep and sluggish stream of hardly 120 yards. The Tibetians consider the Ladakh branch as discharging the greatest volume of water; but the physical configuration of the valley would indicate the Shayook to be eastern prolongation of the Indus.

17. On the 11th of September, we set out on our return to Cashmeer, and ran down the southern bank of the river to the village of Kuchora. We were accompanied thus far by the Rajah as a parting mark of attention on his part. It had been my wish to avoid the route by Astore, in consequence of the

obstruction which I had met with in my journey to Iskardoh. But Ahmud Shah had decided that I was to return by that way, and he assured me that matters had been arranged between him and Jubbar Khan. On the 12th I parted from Ahmud Shah, who at our last interview attacked me on political matters, which I had studiously avoided on all previous occasions. The purport of his conversation was to engage the friendly services of the British Government in India to protect him from aggression by the Sikhs on the side of Cashmeer and Ladakh. I stated to him that I had come into his country with no political functions, but merely as a naturalist; and that besides an interest in his welfare very generally entertained by the British community in India, I could assure him of nothing else. We separated, after mutual expressions of good will, and I ran up the valley of Kuchora to Taukhchund. Thence we proceeded along the western branch of the valley to near Dokus, below the Pass of Rhunnuk, which lay between us and Astore. In the evening it commenced snowing, to the alarm of our Tibetian guides, Rhunnuk being dangerous at all times, and often the scene of dreadful disasters when attempted to be crossed in cloudy weather. It cleared up in the morning, and after a severe and most difficult ascent over extensive fields of snow, we reached the summit in the afternoon. I found the elevation to be 15,822 feet, considerably less than I imagined, as many of our party were attacked with the symptoms of the distress about the head which extreme altitude brings on. We descended to the forest below, and next day followed down the rich but uncultivated valley of Acherope to the village of that name, in the Astore territory. We were received with suspicion and distrust; and matters soon took a turn which gave me considerable anxiety. The few Tibetians sent by Ahmud Shah to escort me were forcibly driven back; and I was left to the chances of such treatment as the Astore chief might be pleased to offer me. To my remonstrances it was answered that I must go on to Astore; and that Jubbar Khan would not allow a dog of Ahmud Shah's to come into his country. After a halt at Acherope, we ran down the valley to near the castle of Astore, and in the evening I had an interview with the Rajah at Phenee. I tried to conciliate him by means of such presents as I had at my disposal, and by a display of satisfaction and confidence which I was far from feeling. We were kept three days at Phenee, during which time I could get no satisfactory answer as to when and by what route I should be allowed to proceed. I was treated civilly, but a good deal of stormy discussion went on in the Rajah's durbar, where a party of Gilghit soldiers, as I had

reason to believe, recommended him to seize our party and property. The inhabitants of Gilghit are notorious slave-dealers. My impression, however, was a good deal conjectural, as the conversation was carried on in the Dardoh language, which none of our party understood. On the fourth day the Rajah dismissed the Gilghit men, and we moved up the Astore river to Gorekote, where we crossed it. There was now a favourable change in his manner, and he yielded to my urgent applications to be allowed to depart; on the 20th we separated, and I pursued my route up to the valley to Bosthone. I have dwelt so much on this part of my journey as having been the only occasion during my absence from Hindostan in which I had any cause for anxiety. I may mention that Jubbar Khan took a fancy to have a European dress, and that in the interview before we parted he was equipped from top to toe in a suit of my clothes.

18. From Bosthone we continued to ascend the valley in a SE. direction along the Astore river to Muenchah and Durloh. The country is rich in natural capabilities for cultivation, but entirely uninhabited, in consequence of long protracted feuds between the Astore and Little Tibet Rajahs, and frequent incursions from the side of Cashmeer. Among other interesting plants, I found one of the Assafœtida-bearing species of *Ferula*, growing in great abundance near Durloh. Although rich in the gum resin, it is turned to no account for the production of this valuable article. Great quantities of the Prangos plant were also observed, but it was nowhere collected for use. From Durloh we continued ascending by the Kummeree valley to Ourle Surtey, and thence to Joojoo-bassa, at the foot of the Kummeree Mountain, which we crossed at an elevation of 13,080 feet above the sea, and descended to the valley of the Kishen Gunga, where we got at Zeean into the province of Cashmeer. From Zeean we proceeded by Goress, and thence across the Kooeehamoo Puntsal into Cashmeer, where I arrived on the 30th September. I made a detour round a portion of the western end of the valley, and reached the city, preparatory to starting for Hindostan, on the 10th October. On the 22nd I set out upon my journey back by the main road through Rajouree and Bimber. I crossed the Peerpungal mountain on the 26th, got to Rajouree on the 30th, and thence by Bimber,[1]

[1] 'The hills between the Punjab and Cashmeer surprised me. In three marches from the west of Peerpungal you get out of the primary mountain formations, and then for nearly five marches you pass across the Sewalik formation. Further up, you have it as behind Nahun, and outwards as at Moginnund. I spent two days at Bimber hunting for fossils, and came upon an embedded mastodon's head, with a cart-load of ivory, but I have only carried off four or five sorted specimens. They are well known to the Mussulman popula-

and along the Punjab, through Vazeerabad and Amritsir, and arrived in the territory at Loodianah on the 23rd November, 1838.

19. To this brief summary of my proceedings I shall add a few remarks regarding the reception which I met with in the different States through which I passed, and mention what I observed regarding the disposition evinced towards the British in India.

20. My best acknowledgments are due for the treatment which I experienced during the whole time that I remained in the Maharajah Runjeet Sing's territories. On all occasions, where I was concerned, a strong desire was evinced in the arrangements ordered by His Highness to mark, by the consideration shown to one of its officers, his respect for the British Government. In my tour around Cashmeer I had the unrestrained power to go where I pleased; and I readily received from the Sikh authorities every assistance that I required to facilitate my objects. I was never able to detect any indication of that jealous concern with which the Maharajah has been supposed to regard the visits of Europeans to Cashmeer. If such existed, it was studiously concealed.

21. The feelings displayed by the Sikh nation indicate no friendly disposition towards the British in India. It would be surprising, perhaps, if the case were otherwise. A highly military race—rude and uninformed—who have hitherto had a career of success, could hardly be expected to look with favour on a power which appears to them to have stood in their way to more extensive conquests.

22. The Mussulman tribes occupying the hill tracts along the Punjab display a strong disposition in favour of the British, and whenever a European goes among them he is sure to be courted and caressed. The oppression to which they are subjected by the Sikhs leads them to an ardent desire for the extension of the British rule over them; and there is a very general impression among them that it will soon reach to the Indus. A similar belief is generally prevalent in Cashmeer, where the hateful misrule and tyranny of the Sikhs have given rise to an idea that they themselves consider their interest in the Valley to be but temporary, and try to make the most of it while they may.

23. My observation was limited in the countries north of Cashmeer to Little Tibet. The friendly disposition of Rajah Ahmud Shah has been long evinced in his communications with Lieutenant-Colonel Wade, and in the kind

tion as *Rakass ki har*. The Sewalik formation, you see, is more developed in this direction than eastward in width.' —*Extract from letter from Dr. F. to Captain Cautley, dated Ningul, November 12, 1838.*—[Ed.]

reception which he has given to English travellers who have visited him. The treatment which I met with was marked by every attention, but tempered with some cautious jealousy in preventing my intercourse with such foreign residents at Iskardoh as could give me information about the country. Iskardoh will always be open to Europeans while Ahmud Shah lives; for he is fully alive to the benefits which he has derived from the little intercourse he has had with us, and to the advantages of the reputation which he has, in the neighbouring countries, of being an object of interest with the British in India.

24. With regard to the results of my journey and the collections formed, I must at present confine myself to a very general statement. In botany, the collection comprises about 3,500 species, with a very numerous series of duplicates; the total number being estimated to amount to 150,000 specimens. It consists of the plants met with in two journies through the Punjab; of a series of specimens from the banks of the Indus near Attock, from Peshawur, the valley of Bunguish, and the salt range in Afghanistan, from the mountains between Attock and Cashmeer, from Cashmeer into Little Tibet, from the Valley of the Indus as high as the confluence of the Shayook and Ladakh River, and from the mountains between Little Tibet and Yarkund. The plants of Cashmeer compose the largest part of the collection, forming a very complete flora of that valley and of the mountains around it. There is, besides, a valuable series of specimens collected by Dr. Lord on the banks of the Oxus, near Koondooz.

25. The details of the collection will be communicated hereafter as they are worked out. I may at present state that it comprises a large number of new species; and that, when taken in conjunction with the collections made by Drs. Hamilton and Wallich, and Messrs. Griffiths and Royle, it will complete a nearly connected series of the flora of the Himalayahs from the Indus down to Assam.

26. With regard to practical results, 653 grafted plants, comprising all the most valuable varieties of fruits found in Cashmeer, were dispatched on three separate occasions to the Botanical Garden at Suharunpoor, where a large portion of them are now in a flourishing condition. The plants which yield Assafœtida[1] and Koost,[2] articles of considerable com-

[1] See 'Description of the Assafœtida Plant of Central Asia,' by H. Falconer, M.D., in 'Trans. Linnean Soc.' vol. xx. p. 285, 1846.—[Ed.]

[2] See 'Account of Aucklandia, a new genus of *Compositæ*, believed to produce the Costus of Dioscorides.' By H. Falconer, M.D., in 'Trans. Linnean Soc.' vol. xix. p. 23.

mercial value, detected in course of the journey, have also been introduced. Of seeds, 587 sorts were collected in Cashmeer and Tibet, in 1838, sets of which have been forwarded to different destinations in England and the Continent of Europe.[1]

27. In zoology, the collection comprises 234 skins of birds, chiefly aquatic; 30 specimens mammalia, chiefly ruminants, among which the following are believed to be new or undescribed, viz. one species of *Cervus*, two of *Capra*, one of *Moschus*.[2]

28. In geology, specimens illustrative of the geognostic structure of the salt range in Afghanistan, of the valley of the Indus near Attock, and of Cashmeer and the surrounding mountains. Of general results in this department I may mention the detection in Cashmeer, at the north-western end of the valley, of proofs of a limited volcanic region of a modern date.[3]

I have, &c.,

H. FALCONER, M.D.

SUHARUNPOOR: *April* 18, 1839.

APPENDIX TO REPORT OF EXPEDITION TO CASHMEER.

(MANUSCRIPT MEMORANDA BY DR. FALCONER).

I.—ON THE CERVUS CASHMEERIANUS[4] (FALC.) OR HANGOOL.

Characters of Male.—Horns round, with three anterior antlers, directed to the front and curving upwards; summit terminating in a fork, with the snags pointing right and left; broad muzzle; large suborbital sinus; canines in both sexes; tail considerable; colour dark-brown and grey; neck shaggy but not maned; insides of the thighs white; a white edge on the buttocks and fringing the tail; no disc on the rump; stature large (equal to that of *Cervus Hippelaphus*).

[1] To botany I have made great additions, but it is the distribution of the vegetable kingdom, or the philosophy of botany, that has yielded me most fruit. Conceive there not being an oak, or a rhododendron, &c., in Cashmeer! There are thousands of them on the ascent up to Peerpungal, but the moment you cross the crest, the botany becomes purely Tibetian, and loses its exclusive Indian or rather Himalayan character. Then as you advance towards Tibet, it becomes more and more Tartaric till it gradually merges into that of the Altai range and Siberia. You can conceive how interesting the development of general laws of this sort, dependent on conditions of climate, are.'—*Letter to Captain Cautley, Cashmeer, January* 11, 1838.—[ED.]

[2] See Appendix.—[ED.]

[3] See page 567, note.—[ED.]

[4] Skulls of the male and female Hangool were presented to the British Museum by Dr. Falconer. In the letter acknowledging their receipt, dated September 22, 1846, the species was erroneously designated *Cervus Casperianus*, and this error has been perpetuated in the British Museum Catalogue of Mammalia, where (at p. 199) the species is designated *Cervus Casperianus*, and *C. Cashmerensis*. (*Falconer, MSS.*)—[ED.]

Dimensions of a Male Hangool.

(First Specimen.)

Total length from muzzle to tip of tail, 7 ft. 1 in. Height from tip of toe to shoulder, 4 ft. 7 in. Height from tip of toe to croup, 4 ft. 4 in. Length of head from tip of muzzle to occipital crest, 1 ft. 6 in. Width of brow over orbit, 7 in. Interval between ears, 8 in. Length of ears, 9 in. Length of fleshy tail, 5 in. Length of horns along curve, 2 ft. 1 in. Interval between inner upper snags, 1 ft. 5 in. Interval between outer upper snags, 2 ft. 2 in. Interval between tips of broad antlers, 8 in. Interval between horns at base, 2 in.

(Second Specimen.—Cashmeer, Jan. 18, 1838.)

From muzzle to occipital crest between ears, 1 ft. 4 in. Interval between orbits, 5 in. Length of ears, 9 in. Width of leaf of ears, 6 in. Girth of head behind eyes, 2 ft. Length of fleshy tail, 6 in.

(Third Specimen.—Cashmeer, April 30, 1838.)

Extreme length, 7 ft. 4 in. Length of head to occipital crest, 1 ft. 9 in. Interval between eyes, 5 in. Interval between ears, 7 in. Length of ears, 9 in. Height at shoulder from exterior of toe, 4 ft. 10 in. Height at croup, 4 ft. 7 in.

(Fourth Specimen.)

Length of head from extremity of muzzle to occipital crest between pedicles, 1 ft. 3 in. Width of forehead between the eyes, 7 in. Girth of head over the eyes, 2 ft. 4 in. Length of ears, 9 in. Length of tail, 5 in. Length of hoof in foreleg, 5 in.

2. *Characters of Female Hangool* (Pampoor, October 25, 1837).—Sub-orbital sinus well marked, but short and deep, being about two-thirds of an inch in both dimensions, or a little less; canines in the upper jaw; muzzle rather small, extending to about two-thirds of height of external nostrils, and reticularly studded with scattered stiff-pencilled hairs; a nearly circular patch of black hair, about an inch in diameter, on the side of the mouth, over lower jaw, at about the middle of the diastème, and opposite the canine.

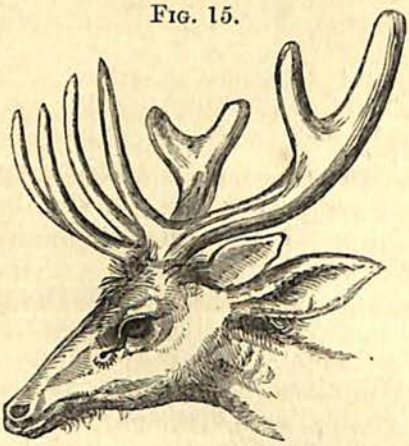
General colour dark-leaden grey, with hairs tipped with reddish-brown, passing along the back towards the tail into brown black, and under the belly into light-leaden or ash-grey, and running into light tan down the legs to the toes; ridge of black running from the occiput along the back to the tail, towards which it increases in width and intensity; tail short, black in the middle, reddish at the tip and tufted, and bordered with reddish-white at the sides; hind aspect of the buttocks marked by a very defined patch of white, running up to and terminating at the angle of junction of the tail, and passing down on the inside of the buttocks towards the thighs; no disc of white on the rump.

Length from extremity of tail to tip of muzzle, 6 ft. 6 in. Length of head from tip of muzzle, to occiput, between and behind ears, 1 ft. $4\frac{1}{2}$ in. Interval between the osseous orbits, 5 in. Length of neck, 1 ft. 4 in. Height from tip of toe to withers, 4 ft. $4\frac{1}{2}$ in. Height from hind ditto to top of croup, 4 ft. 6 in. Length of tail (fleshy part), 4 in. Circumference of chest behind shoulder, 4 ft. 2 in. Length of ears, $7\frac{1}{4}$ in. Interval between ears, 5 in. Width of leafy portion of ears, 5 in. Circumference of neck at middle, 1 ft. 11 in.

General Description.—Legs long; height greater at croup than withers; entire build light and strong; head long; profile straight from between the eyes downwards, but with great gibbosity in the brow between the line of the eyes and ears; nasal arch well defined, and side of the face fined off under it and expanding from the angle of the mouth to the tip of muzzle; muzzle broad; naked portion rather

small, and with the inter-nasal patch of hair running down into an angle on it; sub-orbital sinus short, its direction deflected slightly downwards from the line of the long axis of the eye.

Fig. 15.



CERVUS CASHMEERIANUS. FROM A DRAWING EXECUTED FOR DR. FALCONER BY G. T. VIGNE, ESQ., AT CASHMEER, OCTOBER, 1837.

Colour of head dark-ash or leaden-grey, braided with reddish-brown; tan-brown on bridge of nose, between the sub-orbital sinuses, passing into, and mottled with, light-reddish brown on the frontal gibbosity and

Fig. 16.

CERVUS CASHMEERIANUS. FROM A DRAWING EXECUTED FOR DR. FALCONER BY G. T. VIGNE, ESQ., AT CASHMEER, JUNE 7, 1838.

between the ears, but with a crescentic patch of black to the rear of the gibbosity, with the horns of the crescent downwards; ears long and acuminated, white at the base anteriorly, greyish white and woolly inside, and blackish-tan and rather naked outside.

Inferior surface of the head and face, inferior half of the neck, interscapular, pectoral, and ventral regions, leaden or ash-grey, with the hairs discoloured at the tips, the same colour running down on the inside of the thighs and fore legs.

Upper half of the sides of the neck and flanks of a reddish-brown, as on the brow.

Scapular and femoral regions of a dark-leaden hue, mixed from the discolouration of tips of the hairs, and passing down the outer aspect of the legs into tan-brown.

A ridge of brownish-black, commencing between the ears and running down the crest of the neck along the back to the tip of the tail, gradually spreading out behind the shoulders so as to form the predominating colour of the back and the entire colour of the rump and lumbar region generally, and running gradually into the other colours where the different regions meet; the tail black in the middle, and bordered on the sides by reddish-white, a very defined patch of white descending from the angle of the tail down on the rear aspect of the buttocks, so as to give a border of white when the animal is viewed laterally; tail broad, and of coarse longish tufted hair, but very short. Mammæ 4, inguinal; no inguinal glands; length of toes, 4 inches; circumference of ditto, 8 inches; succentorials large and well defined.

II.—Note on a variety of Musk-Deer, or Kustora.

[Mr. Ogilby, in his 'Mammalogy of the Himalayahs,' published in Royle's 'Illustrations of the Botany of the Himalayahs,' writes as follows: 'Whether the second species of Musk mentioned by Dr. Falconer as having been discoverd during his recent journey into Cashmeer and Little Tibet be founded on more important characters, we have no means of ascertaining, that naturalist not having yet published his observations.'—Ed.]

Male Kustora, killed near Thaneon or Chundunwaree, Valley of Duchenparah, May 19, 1838.

Extreme length from muzzle to tip of tail, 3 ft. 2 in. Length of tail, 2 in. Length of head, 3 in. Length of ears, 6 in. Interval between ears, 1 in. Interval between eyes, 2 in. Girth, at middle of sternum, 2 in. Height at shoulder, when extended on side from tip of toe, 2 ft. 1 in. Height at croup, 2 ft. 9 in. Length of toe of foreleg, $1\frac{1}{2}$ in. Length of succentorial toe of foreleg, $1\frac{1}{4}$ in. Length of canines, $2\frac{1}{4}$ in.

This specimen, an aged male, differs very remarkably from the specimens I have hitherto seen in colour, size, magnitude of musk-bag, and head.[1]

General colour of neck, back, sides, and whole body, a very light ochrey buff, like the Indian jackal, with a tinge of red, and some very faint wavy traces of a darker colour over the shoulder and towards the hips. Head of a reddish brown, particularly above the eyes to between the ears and for a slight way above the opening of the nostrils, brown mixed with grey from thence to between the eyes, and a rufous (or orange-red) patch under the anterior angle of the eyes, extending to along half the opening of the eyelids and crescent-shaped. The same colour on the

[1] 'It is certainly a new species, if not included in Hodgson's catalogue.'—*Letter from Dr. F. to Captain Cautley, dated Cashmeer, March* 20, 1838.—[Ed.]

canine flap at the angle of the mouth. Outside of the ears, rufous dark brown slightly tipped with grey; inside of ditto, at base, dirty white; upwards on the leaf, grey, which also constitutes the margins. Outside breast, rufous ochrey tipped with grey, passing, on the underside of belly, breast, and down the legs, into slate-blue, mixed with grey; legs pepper-and-salt grey, with some admixture of rufous on front; toes, dirty greyish white.

Another remarkable character is a crescentic or semicircular flap (canine flap) descending from skin of upper lip over the canine, so as to reach the edge of the chin. This flap of skin is not observed in other specimens; no bristly hairs at angle of mouth, nor white patch, as in the common Cashmeer variety.

This individual, an aged male, with canines $2\frac{1}{4}$ inches long, is much smaller than the common dark variety. Musk-bag much larger; all the Shikarees who have seen it declare the specimen to be rare, and only found in the neighbourhood of Tibet, where it was killed, and where we now are, and the peculiarities are so marked that I consider it a distinct species.

The specimen is moulting; the hair on the brow coming off in patches.

III.—The Goats of Cashmeer.

[In a letter from Cashmeer in 1838, to Captain Cautley, Dr. Falconer remarks:—'There are no fewer than three species of wild goat near Cashmeer, the Ibex of the Snowy Range the same as I got from Everest, the Tehr (*Capra quadrimammis*), and the Markhor,[1] a noble goat, with horns twisted exactly like the blade of a sword, and as long and diverging as those of the antelope. I went after the Ibex for five days, and saw numbers, but only got a young male.'

The following is a description, by Dr. Falconer, of the Rev. R. Everest's specimen of the Ibex, taken from a letter written to Mr. Hodgson, about 1835, but probably never sent.—Ed.]

I have never noticed in any of the synopses published in the Journal of the Asiatic Society or elsewhere, by you, any mention of the Ibex of the Snowy Range. Does it occur in the Nepaul snow frontier, or is it included in the drawings of the illustrations of Nepaul zoology? Your series is so complete otherwise, that it were a pity if the Ibex should be wanting. The Rev. Mr. Everest has just returned from a trip nearly as far as the Chinese frontier, on the Spiti River in Upper Kunaor, and brought back with him two specimens of the heads of the male, and an entire stuffed skin, from all which a very tolerable idea of the animal could be made out. It abounds in the snowy ridges of Kunaor, along with the *Bhurroor*; but it is an infinitely larger animal, and I imagine by far the largest caprine species known. I suspect also it is specifically distinct from the Ibex of the Alps, and very markedly so; but I have no description of the latter at hand to refer to. The intra-orbital portion of the forehead is more concave, and the nasal portion of the chaffron more convex and prominent than in any ruminant I have ever seen described. The stuffed specimen is now in my possession, and here are some of the dimensions.

Extreme length of shrivelled skin from extremity of the tail to tip of muzzle, 7 ft. 4 in. From tip of toe to the croup, 3 ft. 9 in. From ditto to withers, 3 ft. 9 in.

[1] This is the *Capra Falconeri* of Hugel; the *Aigoceros Falconeri* of Wagner.—[Ed.]

Length of tail (exclusive of hair), 4½ in. Length of horns along the curve, 42 in. Length of chord, 24½ in. Versed sine (from chord to upper curvature), 11½ in. Divergence at the tips, 29 in. Greatest divergence, 30 in. Interval between the horns at their base, 1 in. Circumference at the base, 10 in. Antero-posterior diameter at the base, 3½ in. Transverse diameter at the base, 2½ in. Length of hoof, 4 in.

The animal is singularly party-coloured. Horns start from the head, on the same plane with the brow, and then gradually curve upwards, backwards, and outwards, with an increase of curvature and sudden inflexion near the tips, and with eighteen transverse distant ridges (incomplete rings) along the upper curve.

Muzzle hairy, tan-brown passing upwards into light hazel-brown on the forehead and behind the ears. Chin, cheeks, under surface and sides of the neck, shoulder, and hips, liver-brown, with the hair tipped greyish, gradually passing down the fore and hind legs into deep reddish brown. A large roundish patch of dirty greyish white on the upper side of the neck, extending from behind the occipital to the top of the shoulders. Shoulder patches meeting at the croup and sending off a narrow ridge of long, tufted, reddish-brown hair, along the spine of the back to the tail. Back, sides, and flanks, entirely of a dirty greyish white, passing downwards into hazel brown. Under side of the chest and belly, dark slate-grey, mottled and mixed with tan-brown. Tail short and black, 4½ inches long; ears erect, hazel-brown outside, tan inside. Mammæ four. No trace of sub-orbitary sinus. Beard full, dark liver-brown, tipped with reddish-brown. Hair very thick, erect, stiff, and rather short, with a very thick coat of shawl-fleece at the roots.

IV.—Note on the Mule Breeds between the Yak and the Cow, in Tibet.

For agricultural purposes the Tibetians find a cross between the Yak (*Bos grunniens*) and the common Cow of the mountains to be more serviceable than either of the pure stocks—for the labour of the plough especially. The crosses are chiefly made with the male Yak as the sire, and the common Cow for the dam. The mule produced in this instance is called: the male, '*Bsoh*,' the female, '*Bsohn*.' The 'Bsohn' is then again crossed with the male Yak, and the produce called: the male, '*Gŭr*,' and the female, '*Gurmoh*.' The Gurmoh is again crossed with the Yak and has a produce which returns to the Yak;[1] the male of this breed is fertile and capable of propagation, the males of all the intermediate breeds being sterile.

The Tibetians do not practice raising a cross between the Cow Yak and the common Bull. The reason given is that the experience of the country, as derived traditionally from their fathers, is against it, and that where the cross has accidentally taken place the produce is inferior.

The Yak, as compared with common Oxen, is an unstable, uncertain-tempered animal, impatient of long fatigue, and does not take kindly to the plough.

The 'Bsoh'[2] is a larger animal than the Yak, and more robust.

[1] In stating the cross to return to the Yak, it is merely meant to convey the impression of the people, probably derived from the fact of fertility in the third cross.

[2] The mules which were seen of the Bsohn were larger than the generality of the common cattle observed in the country.

The Gurmoh is smaller than the Bsoh; each of these crosses takes after the sire in the Bisonic form of the head, but has shorter hair, and the characteristic chowry tail much less bushy. The Bsoh shows something of the dewlap, and has longer limbs and is of less compact build than the Ox. The temper improves, and the eye, which is fiery and restless in the Yak, becomes quieter.

One reason of the breed is perhaps that the cross affords an animal more tolerant of heat on the one hand than the Yak, which suffers extremely at a low altitude in summer, and on the other hand hardier than the common Cow, and able to sustain the severest cold, partaking thus of the good qualities of both originals. The Yak browses freely on species of *Artemisia*, which are abundant on the dry hills of Tibet, forming in many instances the only vegetable coat which the soil has.

The Yak is chiefly used as a beast of burthen, and in the upper parts of Tibet it is ridden, but travels at a very slow pace. The mules are kept for draught or the plough, and the common cattle for their milk.

The above particulars are from notes taken at the time in the country.

V.—The Cashmeer Martin.

Mustela.—Sub-genus *Martes.*—Incis. $\frac{3-3}{3-3}$, canine $\frac{1-1}{1-1}$, cheek teeth $\frac{5-5}{6-6}$ (viz. false mol. $\frac{3-3}{4-4}$ carnass. $\frac{1-1}{1-1}$, tubercular $\frac{1-1}{1-1}$) $= \frac{18}{20}$ $=38$.

Martes Macroura (Falc.), Long-tailed Cashmeer Martin.—Head, face, and back of neck, blackish brown; lower jaw and a salient cheek patch under the ear, dirty white; throat, sides of neck and breast, yellowish; body dirty yellow, graduating backwards into dirty brown; crupper, flanks, hind legs, and lower portion of forearms, dark sepia, passing downwards into blackish brown: ears blunt, concolorous with the head; tail black; body vermiform. Length of head and body 25 inches; tail 17 inches (fleshy portion 16).

Described from a full grown female, March 28, 1838.

VI.—The Tibetian Hare.

Extreme length from tip of fleshy tail to muzzle, 1 ft. 11 in. Length of fleshy tail, 4 in. Length of hairy tail, 5 in. Length of ears, 5 in. Width of leaf of ears, 3 in.

General colour mixed grey, rather light, with a lead-bluish tinge on buttocks, and slightly rusty on neck; head greyish brown; ears long, tipped on the outside with black; tail very long, black above, white underneath and at sides; breast, belly, and inner side of the legs white; mammæ, 4, ventral. It is a rusty red, long-legged, lanky hare, weighing about 4 lbs.[1]

[1] Dr. Hooker, in his account of the Cholamoo Lakes in Tibet, observes: 'There were also many slate-coloured hares with white rumps (*Lepus oiostolus.*)'—Himalayan Journals, ii. 157.

VII.—ARCTOMYS TIBETANA. TIBETIAN MARMOT.[1]

(*Tibetian 'Pfyah'; Dardoh 'Trŏoshkŏon'; Cashmeer 'Drin.' Tibetian Marmot of Moorcroft*).

Characters.—General colour rufous yellow; brownish black on the muzzle, crown of the head, back, tip and under side of the tail; throat, under part of the body, and legs of a bright rusty red; ears inconspicuous, short, thin, and pointed; tail half the length of the body, grey above, flattened. Upwards of three feet long; tail 13 inches.

Inhabits the elevated plains and valleys of Tibet, Muttayen near Drass, Deosoh, and Sookarun Murbul, between Boorzillah and Bulleh Teerchoo.

Dimensions of a full grown female:—

Extreme length from tip of tail to point of the muzzle, 38 in. Length of fleshy portion of tail, 11½ in. Total length of tail, 13 in. Length of hind paw, 4 in. Girth at the belly, 22 in.

The Tibetian Marmot belongs to the section of the true or social Marmots, 'Arctomys,' of F. Cuvier, as distinguished from 'Spermophilus' or the solitary Marmots. It is perhaps the largest species of the genus. The general colour of the body is a reddish yellow, with brownish black from the back of the head along the back, passing on the rump into yellowish grey. The sides are of a light yellow, the underside of the neck, breast, belly, and the legs of a bright rusty red; the muzzle, chin, angles of the mouth, and a patch around the eyes are black; forehead reddish yellow, mixed with black; tail yellowish grey above from the rump, brownish black at the extremity, and mostly so underneath.

The body, as is characteristic in the genus, is bulky, loose, and heavy, the head large, the muzzle short and thick. The ears are hardly apparent till the head is closely looked at, and are pressed to its sides, hairy on both sides, obliquely sloped off behind, and rather pointed. There are no cheek-pouches, but a broad fold of loose skin, with long erect hair, is continued from the sides of the neck under the ears and eyes to the angle of the mouth, giving the appearance of a sort of ruff to the face, and confounding the head, neck, and body together. The whiskers scanty, and the upper bristles only of considerable length; the teeth are, as is normal in the genus, two incisors above and below, and five cheek-teeth above and four below, on each side. The incisors are thick and stout, rounded in front, and compressed on the sides. The upper cheek-teeth have two transverse sharp ridges meeting on the inner side in a connecting tubercle with a subordinate ridge on the anterior and posterior sides—the anterior tooth consisting of a simple projecting

[1] Mr. Ogilby, in Royle's 'Illustrations of the Botany of the Himalayahs' (1839) refers to Dr. Falconer having mentioned the Tibet Marmot in his report of his journey to Cashmeer, but adds that there was no further knowledge of its characters (i. 67). This Marmot was, however, described and figured by Mr. B. H. Hodgson in the Journ. As. Soc. for 1841 (vol. x. p. 777), as *Arctomys Himalayanus*. Two years later (vol. xii. p. 409), he described another smaller species of Marmot as inhabiting the Himalayahs, and suggested that the term *A. Tibetensis* would be more appropriate to the larger species. The Tibetian Marmot is also figured by Dr. Hooker, in his 'Himalayan Journals,' ii. 93.—[ED.]

tubercle, surrounded on the inner side by a sweep of enamel. The lower cheek-teeth have four tubercles at the angles, connected by longitudinal and transverse low ridges. The legs are short and wrapped in loose skin; the paws large and strong, furnished below with a thick elastic pad under the skin; the toes long and distinct to the second joint, the forepaws with four toes and a knobbed rudiment of a thumb, the hind paws 4 inches long, with five toes; nails stout, compressed, and slightly curved. The tail long, equalling half the length of the head and body, the fleshy part being $11\frac{1}{2}$ inches, flattened and furnished with long dense hair. The fur on the back and sides is long, close, and rather coarse, but not harsh; very scanty underneath on the chest and belly. The ruff on the sides of the head composed of erect stiff bushy hair. The eyes are large and black.

This Marmot forms an entirely distinct species, characterized by its large size, brilliant colour, and long tail. It was first observed by Mr. Moorcroft in his journey from Tibet to Cashmeer, and described by him as resembling a young hare.[1] The animal has in consequence been conjectured to be a Lagomys. To me there is nothing in its appearance or habits that conveys the idea of a young hare. I learned in Cashmeer, from a person who accompanied him, that M. Jacquemont shot numerous specimens at Muttayen, between Drass in Tibet and Sir-i-cottul, the mountain pass which separates Cashmeer from Tibet.

The animal is entirely confined to the Tibetian region, and chiefly to the northern face of the Himalayahs. Mr. Hodgson, in his Catalogue of the Nepaulese Zoology inserts an *Arctomys Himalayanus*;[2] but as the notice is unaccompanied by any details, I know not whether his animal is the same with the Tibetian Marmot, or whether it was found on the northern or on the southern side of the Himalayahs. But certainly neither this nor any other species of Marmot exists on the southern front of the range from the river Gogra to the Indus. Nor does it appear to be found in Kunaor, which partakes of the climate and productions of Tibet, and has a language in common with it. Excellent observers, such as the Rev. Mr. Everest, Captain Herbert, and many others, have ascended high up the valley of the Spiti without having noticed it. In the Tibetian regions it is found all along from near the lake Manasarovara to the banks of the Indus, where it first bends to the south. In Cashmeer I was informed of its existence towards the heads of the valleys of Duchenparah and Shalimar, which are conterminous with Ladakh, but nowhere along the Puntsal or snowy range forming the mountain boundary of Cashmeer on the side of Hindostan.

The Drin is a beautiful animal, and interesting both in its habits and on account of the dreary regions which it inhabits. There, on the confines of eternal snow, it is the almost solitary type of animated existence. I first observed it on descending the northern side of the Boorzillah range, which intervenes between Little Tibet and the valley of the Kishen Gunga, early in the month of August, but 300 or 400 feet below the belt of perpetual snow, and high above the region of the birch, the rhododendron, or juniper. This is the favourite habitat of the animal, where but a few grasses, the Tibetian *Rumex*, *Polygona*, *Pediculares*,

[1] Royle, Illustrations of Botany of Himalayahs, 1839, Introd. i. p. 37.

[2] Catalogue of the Nepaulese Zoology on wrapper of Journal of the Asiatic Society, No. 65, for May 1837. (See p. 583, note 2.—Ed.)

and Primroses have their upper limit; and it may be said that its Alpine propensities are only restricted by the absence of vegetation and the incapability of the soil for being burrowed in. It inhabits alike the elevated plateau of Tibet, or the heads of its most alpine valleys. It is eminently social in its habits. The traveller, after crossing a lofty ridge and traversing a snow field, descends into a bleak tract where there is nothing to remind him of an animated creation besides the companions or attendants who may be with him, and suddenly sees below him a large community of animals which look golden-coloured in the distance, young and old collected together within a small space. On the top of a large stone or rock is seen a prominent figure on the watch, who, by the vivacity of his movements and the intentness of his gaze, shows the interest he takes in the approach of the stranger. He raises himself erect on his hind legs, turns one side of the head and then the other in quick succession towards the object of his suspicion, and, on assuring himself of its nature, utters a loud clear and shrill cry; the other members of the community instantly take the alarm, the young make at once for the burrows, and the old endeavour to get a sight of the object of alarm, and if the nature of the ground prevents this, they also betake themselves to the burrows. The sentinel meanwhile keeps quickly repeating his cry, and maintains his ground till the advance of the stranger to within a few yards endangers his personal safety, and he rapidly retreats. After the lapse of a few minutes a head is seen cautiously protruded out of one of the holes, making a rapid circuit of inspection. If any cause of alarm is observed it is speedily withdrawn, and no cry uttered; if nothing is seen the body comes out with extreme caution, and if the stranger has gone on he is soon apprized by a shrill cry from behind him that the sentinel has again taken to the post where he first saw him, and the community is informed that the object of alarm has passed by, and the members again issue forth to bask in the sun. The station for the burrows is usually near the base of the sloping ridge of a valley, or, if the ground is level, the most elevated part of it is selected, so as to guard against flooding from melted snow or rain. With regard to soil the animal appears to be indifferent. At Sookarun Murbul, below Boorzillah, the ground is entirely composed of fragments of granite, covered by a scanty stratum of clayey soil. Here the burrows were numerous, and their excavation must have been attended with difficulties which would have defeated a less skilful pioneer. The excavated matter at the mouth of the burrow consisted entirely of granite, pebbles, and gravel, and its direction must have been devious to a degree, from the intervening blocks of granite met with in the course of digging. The burrow at its mouth goes off downwards at a considerable angle. If a raised block of stone happens to be near, the excavated materials are thrown up into a careless mound. But if not, the ejected gravel is dressed up into an elevated broad glacis, which slopes rapidly into the mouth of the burrow. This spot is the favourite station of the Drin, where he may be observed basking for hours in the sun. Near the same place I saw several individuals perched on blocks of stone forming the talus of a granite cliff, and uttering their shrill cry on my approach. Here the habitation of the Drin appeared to be merely the casual crevices left between the blocks of stone. The burrows, where the ground admits, are close together, and as much so as in the most crowded rabbit warren in

England. The slope at the mouth is tidy and clean, and filth or droppings are rarely seen near it. Judging from the number of burrows on one spot, and the individuals seen about them, a community varies from twenty to fifty members, young and old.

The Tibetian Marmot is a diurnal animal; from sunrise to sunset young and old may be seen about the warren, gnawing plants or basking in the sun. During the day it never appears to retreat to its burrow, except on the approach of a suspicious object. It is rarely seen more than a few yards off from the warren, and if suddenly come upon at a greater distance it is easily outrun and caught by the hand. But this seldom happens. Although so abundant where its station is, a specimen is not easily got. On the approach of man they retreat to the mouth of the burrow, and after receiving a ball or a charge of shot, if a spark of life remains, they wriggle into their den and slide down out of reach. The cry is peculiarly clear, loud, and shrill, and it somewhat resembles the sound of 'chēēoo' raised to an octave. It has also something ventriloquial about it. When the eye does not guide the ear to where it is uttered, one looks a few yards ahead, expecting the animal to be close under his feet, while the little trumpeter is soon detected seated perhaps a hundred yards off. On uttering the cry the Drin stretches out its neck, and bends the head down like a cock at the finishing note of his crow, and the movement is such as to convey the idea that the animal is about to take to flight.

The Drin exists in vast numbers in the elevated tracts of Tibet; it has no enemy in man, nor any predaceous foe to control its prolific production. The Tibetians do not eat its flesh, nor do they hunt it for its fur, although in other countries the latter would be an article of commerce. Its natural enemies, such as the eagle and the *Mustelidæ*, are nowhere seen. The latter could not exist the whole year in the region of the Drin, and were they to invade it in the summer months they would first have to pass through an intermediate lower belt, where they would find nothing to feed upon; and this circumstance is perhaps the security of the Marmot. Were the *Mustelidæ* to reach so high, their production, from the vast abundance of food, would soon be so great that numerous traces of them would be seen about the haunts of the Drin, and the latter would soon be suppressed in number. But nothing of either sort is observed. The only controlling agency upon the excessive production of the Marmot is probably the avalanche, or an unusually heavy fall of snow during the winter, either of which might extend the period of hybernation to a whole community longer than the powers of life could sustain.

XXIX. MISCELLANEOUS NOTES ON INDIAN ZOOLOGY.

BY H. FALCONER, M.D.

I.—Note on Cervus Duvancellii. (*Cuv.*)

The deer and antelopes of India are still but imperfectly known, and much doubt exists about the number and character of the species. Much has been done by Indian naturalists lately, but a great deal remains to be accomplished. The number of species in the group of the genus *Cervus*, called *Rusa* by Hamilton Smith, is by no means settled, and the characters of the species are ill-defined. Mr. Hodgson has thrown much light on the Rusine deer of Nepaul, and the tract of Terai below it, as well as on every point connected with the zoology of the Himalayahs to which he has given his attention. I entirely agree with him that the characters derived from the horns, as restricted to the subgenus *Rusa* by Major H. Smith, are insufficient. The *Kalo Jarai* figured by Mr. Hodgson in the 1st volume of the Journal As. Soc. (p. 115) has no terminal subdivision of the beam, and no branch from the horn but the brow antler. The animal now to be noticed forms another exception from the group, in having the beam divided into four subterminal branches, but in other respects possessing all the characters of the *Rusa*, I believe, in so far as could be determined from the fresh head.

Subgenus Rusa.

Cervus Eucladoceros. (*Nob.*)[1]

Stature very large; horns round, slender for the size, roughly ridged and furrowed; basal antler anterior, long, thrown off at a large angle; beam reclining, divergent, quadrifurcate, giving off above the middle an internal bifurcate branch with snags of unequal length, and terminating in a fork with nearly equal processes; sub-orbital sinus large; muzzle broad; canines.

Head large; ears large, lined with long whitish hair. Horns massive near the burr, 7 inches in circumference, $2\frac{1}{4}$ inches apart on the brow. Bez antler low, long, anterior and erect, slender, slightly recurved, roughly ridged to about three-quarters of the length, and tapering into a very smooth and sharp ivory white point, thrown off at an angle of above

[1] This note was written in 1835 or 1836, but was never published. In a drawing of the specimen described, the species was subsequently designated in Dr. F.'s writing, *Cervus Duvancellii*. The species appears to be the *Cervus Elaphoïdes*, or the *Bahraiya* of Hodgson. (See Cat. Mam. in Brit. Mus. p. 204.)—[Ed.]

80° from the beam with which it forms a broad-ridged or mammillated fork. Beam reclining, slightly curved forwards, divergent, round, bluntly ridged, slender for the size, 5½ inches in girth, divided above the middle into four prongs, viz. a branch thrown off inwards and backwards, bifurcated laterally; the inner snag very short, the outer three times longer; the beam then rising some distance, and terminating in a perch; the processes nearly equal, anterior and posterior; the anterior smooth, pointed and slender, like the bez antler; the anterior incurved, forming the summit of the beam, the posterior nearly erect.

There is some slight difference between the horns of the opposite sides. The above description is of the left one; on the right side, where the subdivision of the branches commences, the beam is flattened, and the offset of the branches approaches palmation. In other respects the horns are alike. A plane on the anterior surface of the terminal prongs would form a curve.

Length of the head from base of the horns to tip of the muzzle, 1 ft. 2 in.; ditto from the occipital ridge to ditto, 1 ft. 8 in. Width from tip to tip of the ears 2 ft. Length of the horns along the curve, 2 ft. 11 in.; ditto, straight line along the chord, 2 ft. 5 in.; ditto of the intercornual axis, 2 ft. 1½ in. Interval between the horns on the brow, 2⅔ in. Divergence of the tips, 2 ft. 5 in. Greatest interval between the horns, 2 ft. 8½ in. Length of the brow antler along the curve, 1 ft. 4½ in.; ditto straight from perch to tip, 1 ft. 2½ in. Offset of ditto from the burr, 2½ in. Interval between the points of ditto, 1 ft. 6 in.; ditto, from ditto to the middle of the beam, 1 ft. 4 in. Length from burr to lower terminal fork on the beam, 1 ft. 5 in.; ditto from the lower to the upper terminal fork, 6½ in.; ditto of the anterior terminal branch process, 1 ft. 11 in.; ditto, of the posterior ditto, 10 in.; ditto of the outer snag of the lower fork, 6 in.; ditto of the inner snag ditto, 2½ in. Divergence between the tips of ditto, 1 ft. 3 in.

I had no means of ascertaining the dimensions of the body, as only the fresh head was sent to me. Mr. Money, C.S., from whom I received it, described the animal as large. He was one of a party of three who shot twenty-one of the deer in one day, large and small. The deer had a long shaggy mane on the neck, and long hair on the throat. The colour of the head was a dusky greyish brown, but tawny above the muzzle; that of the body was described as of a dark brown. It was shot in a jhil on the west bank of the Ganges, south of Hurdwar. It may be considered as inhabiting the Sub-Himalayan terai.

I apprehend there can be little or no doubt that this deer belongs to the *Rusa* group. I have a nearly full-grown female *Jurao*, and a young male that has not yet thrown out horns. Along with the head I have described I received the head of a young deer, with the sample horns of the first year's shoot, shot at the same time with the large one. The heads respectively exactly resembled the living young male and the adult female; and the expression of the heads was precisely alike in both. The heavy mane on the neck, the rise and sigmoid flexure of the sub-orbital sinuses, and the large muzzle, added to the other points of similarity, leave no doubt that the species is a *Rusa*.

I am also of opinion that the species is distinct from the animals described by Mr. Hodgson, the *Kalo*, *Rato*, and *Phusro Jarais* of Nepaul, and the *Rusas* of Major H. Smith. If any importance attaches to characters derived from the horns, it cannot be regarded as a variety. The slender form of the horns, the great length and large angle at which the bez antler is thrown off, and the four-pronged termination of the beam, although either might have existed singly in a

variety, in conjunction must be regarded as indicating a distinct species. Perhaps the *Rusas* might be conveniently distributed into three sections:—

I. Those with brow antler and simple beam: *Kalo Jarai*, Hodgson.

II. Those with bifurcated horns. The *Rusas* of Hamilton Smith.

III. Those with slender horns and four-pronged beam, including the animal above described.

I am not aware of any native name for this deer. On this point there is much confusion, which has added greatly to the difficulty of discriminating Indian deer. The *Saumur* of the lower provinces is called the *Maha* in the upper part of the Doab; and these names appear to be applied to more than one species. The Rusas of Nepaul are called *Jarai*; in Kumaon, and the Jumna-Gangetic tract of the Himalayahs, they are called *Juraos*. What is the *Bara Singha*? Hamilton Smith says it is the *C. Hippelaphus*; and Mr. Hodgson says it is a splendid variety of the common stag, or *C. Elaphus*. Should this notice reach the eye of Mr. Hodgson, I would suggest his reconsidering this opinion, or favouring Indian naturalists with his reasons for thinking so. In the upper part of the Doab, *Bara Singha* is applied to any large deer by the natives, particularly to such as have any remarkable development of the antler. Many sportsmen say it is a deer with six branches on each horn; but I have never met with anyone who could specifically say what the deer was. It would be well if the term *Bara Singha* were settled, and applied specially to some one of the large deer.

II.—Note on an Indian Species of Esox.

Esox (*Belone*) *Hindostanicus* (*Falc.*).

Malacopterygiens abdominaux, Cuv.; Gen. *Esox*.—Muzzle long and attenuated, with a large gape; upper jaw with its sides composed of the intermaxillaries, which have a posterior pedicle, the maxillaries being concealed under the tips and not entering into the composition of the jaw; teeth in both jaws, some of them long, pointed, and distant, the intervals occupied by a row of smaller teeth; no teeth in the palate. Lower jaw projecting beyond the upper; no adipose fin or barbillæ; opercula and branchial openings large; body and tail elongated, the latter compressed at the sides; scales cycloidal, small, hard; dorsal and anal fins short; one dorsal fin placed right above the anal.

Subgen. Belone, Cuv.—Dorsal fin with 16 rays, anal fin 18 rayed; branchial membrane 14 rayed; caudal fin, with a nearly rectilineal termination (no échancrure), 19 rayed; head rather small; lower jaw extending beyond the upper, both being straight, and twice as long as the head proper; body and tail cylindrical and serpentiform; two longitudinal ridges, with an intermediate ridge, and bounding furrows along the back; a mesial lateral line from the tail to the opercula, and a longitudinal coronated line of scales on either side towards the belly. Pectoral fins 9 rayed; ventral fins 6 rayed.

The muzzle long and needle-shaped; total length of body and muzzle about $8\frac{1}{2}$ inches; diameter of the body half an inch; the teeth are of two sorts—one very long and needle-shaped, rather distant, the other shorter and occupying the intervals; eyes very large; head flattened

above, with a deepish and broad longitudinal furrow; a membranous pouch under the fork of the inferior maxillaries; body green above, white underneath; intestine short, straight, and thick; no cœcum.

Called by the natives of Hindostan 'the Cowah Muchee,' or Crow-billed fish. Sometimes attains 18 inches.

Forms a distinct species, nearly allied to the marine *Esox Belone* of Cuvier, but differing in number of rays to the fins, and in having a straight ended, not forked, tail.

Inhabits nullahs and stagnant waters at Suharunpoor; common.

Swims horizontally, with a zig-zag motion, like an eel. Is eaten by the natives.

III.—Memorandum regarding the Predaceous Habits of Indian Frogs in an instance observed by Mr. J. Wright.

About the end of August, 1840, Wright one evening was seated outside the house on the terrace, and saw one of the large yellow rain frogs of Hindostan quietly crouched under a raised piece of timber, close to the terrace. There happened to be a quantity of chaff and grain strewed over the adjoining ground near the terrace, left there after feeding fowls. Several sparrows were attracted by the sight of the grain, and settled upon the spot. The movements of the birds hopping about and picking the grain soon appeared to arouse the attention of the frog, who evinced his interest by raising himself on his hind legs, and vibrating his body rapidly backwards and forwards without leaving his cover under the wood. At length one of the sparrows hopped to within *four* or *five feet* of him, when, in one spring, he threw himself most accurately on the bird, and seized it in an instant, taking the head, neck, and body at once into his gape. He then sprang back to his cover, and was vigorously endeavouring to swallow the bird, when Wright, who was attentively watching what was going on, got up, pushed the frog into a corner, where he was able to lay hold of the reptile, and seizing the sparrow's legs, compelled the frog, after a determined resistance, to disgorge his prey. The sparrow had a spark of life remaining when drawn out. The correctness of these particulars is hereunder authenticated by Wright.

'The above statement is strictly correct.

'J. H. S. Wright.'

Suharunpoor: *July* 15, 1841.

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